Removal Action Work Plan

The Lockformer Company
Lisle, Illinois

Clayton Project No. 15-65263.01.004
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1.0 BACKGROUND

1.1 INTRODUCTION

The purpose of this Removal Action Work Plan (RAP) is to present an immediate removal strategy for soil in the trichloroethylene (TCE) fill area of The Lockformer Company (Lockformer) facility located at 711 West Ogden Avenue, Lisle, Illinois (site).

1.2 OBJECTIVE

The objective of the removal action presented in this work plan is to effectively reduce the elevated concentrations of TCE in soil in the vicinity of the former TCE fill pipe on the west side, and under, of the Lockformer building and lessen the potential for migration of this contamination to groundwater.

1.3 SITE DESCRIPTION

The site is located in south-central DuPage County, Illinois (Figure 1). The site consists of an east and west parcel that encompass a total of 18.5 acres (Figure 2). The east parcel consists of approximately 6.54 acres and is occupied by a single structure with associated landscaped and drive/parking areas. The structure is utilized by Lockformer as a manufacturing facility for production of sheet metal processing equipment and roll forming machines. The west parcel consists of approximately 11.96 acres of undeveloped land. The site is located in a mixed area of industrial, commercial, and residential use, approximately 1,300 to 1,800 feet west of Interstate 355.

The site is bounded to the north by Ogden Avenue, beyond which exists a residential subdivision; to the east by new construction (Bill Kay car dealership); to the south by a surface water retention basin servicing the Bill Kay property (beyond which exist

single-family homes) and the Burlington Northern railroad (beyond which exists St. Joseph's Creek); and to the west by a multi-unit commercial building.

Soil impacted by TCE was first discovered in the fall of 1991 during underground utility (water line) repair work conducted at the west side of the site building. The largest source of the impacts is believed to have resulted from filling operations of the roof-mounted TCE tank formerly located at the site. The tank was located on the roof of the west side of the building (Figure 2) and was equipped with metal fill and vent pipes that extended down the west building wall to approximately 4 feet above grade.

1.3.1 Topography

Clayton obtained and reviewed a topographical survey for the vicinity of the site from DuPage County. The topographical information for the site is illustrated in Figure 3. In general, the site's west parcel is higher in elevation than the east parcel. However, both parcels slope to the south/southwest. The eastern portion of the east parcel slopes east. A low-lying (ditch) right-of-way is located at the western edge of the east parcel and the eastern edge of the west parcel. Elevations on the east parcel range from approximately 714 feet above mean sea level (msl) adjacent to Ogden Avenue to approximately 700 feet above msl at the most southwestern portion of the parcel. Elevations on the west parcel range from approximately 714 feet above msl adjacent to Ogden Avenue to approximately 684 feet above msl at the southern portion of the parcel.

1.3.2 Geology

The site is located within the Wheaton Morainal section of the Great Lakes physiographic province. Based on the Illinois State Geological Survey (ISGS) Circular 460 *Summary of the Geology of the Chicago Area - 1971*, the uppermost surficial glacial deposits present at the site consist of undifferentiated Valparaiso Moraine deposits. The Valparaiso

Moraine includes a buried drift of questionable age, informally called the Lemont Drift, which consists of yellow-gray silty till, sand and gravel, and dune sand. The deposits are generally overlain by a thin Richland Loess or modern soil *(Illinois State Water Survey/Ground Water Resources of DuPage County, Illinois - Cooperative Ground Water Report 2 - 1962)*.

Based on the ISGS Circular 532 *Potential for Contamination of Shallow Aquifers in Illinois-1984*, the site borders upon Cahokia Alluvium depicted as Ax deposits and/or C1 depicted deposits. The Cahokia Alluvium consists of unconsolidated, poorly sorted sand, silt, or clay containing local deposits of sandy gravel. These modern deposits are generally found in floodplains of streams and rivers. The thickness of the alluvium is variable and may directly overlie Silurian Age bedrock consisting primarily of dolomite. C1 deposits consist of greater than 20 feet of glacial till (mainly pebbles and cobbles in a clay, silt, and sand matrix, deposited directly by glacial meltwater) and other fine-grained material of the Wisconsinan Glacial Stage. A thin layer of loess (windblown silt) and modern soil, ranging in thickness from 0 to 2 feet, may mantle the glacial deposits in this area.

The Paleozoic bedrock underlying the glacial deposits consists of about 3,500 feet of consolidated, stratified, sedimentary rocks of Cambrian, Ordovician, and Silurian ages. The formations dip gradually to the east and southeast at about 10 feet per mile and are folded into a series of gentle anticlines and synclines. The glacial deposits at the subject property rest upon a synclinal fold of Silurian-aged bedrock of the Niagaran Series. The Niagaran rocks range from clean dolomite to highly silty, argillaceous, and cherty dolomite with some thin shale beds and may contain reefs locally *(Illinois State Water Survey / Ground Water Resources of DuPage County, Illinois - Cooperative Ground Water Report 2 - 1962)*.

Since beginning investigative activities in 1992, a series of subsurface investigations have been conducted at the site to evaluate the extent of VOC contamination. The investigations have included the advancement of approximately 146 soil borings to facilitate the collection of discrete soil samples, and the installation of 46 monitoring wells to facilitate the collection of groundwater samples for chemical analysis. A large number of these soil borings and groundwater monitoring wells have been installed in the vicinity of the TCE fill pipe source area. Several of these borings and groundwater monitoring wells in the vicinity of the TCE fill pipe are depicted in Figure 4. Figure 4 also provides the lines for cross-sections SA-1/SA-1' and SA-2/SA-2.' Cross-section SA-1/SA-1' appears in Figure 5. Cross-section SA-2/SA-2' appears in Figure 6.

Based on subsurface investigations previously conducted in the vicinity of the TCE fill pipe, the lithologies underlying the source area consist of cohesive, silty clay glacial till and fill from surface grade to an elevation of approximately 675 to 680 feet above msl. The silty clay is underlain by a mass waste deposit of predominantly composed of sand and gravel and containing variable amounts of silt and clay. It is readily distinguished by its high percentage of angular gravel clasts composed of dolomite. It is typically very poorly sorted, and grades to a sand and silt toward the base of the deposit at some locations.

A cohesive, silty clay lower glacial till underlies the mass waste deposit at an elevation of approximately 660 feet msl. The lower silty clay till extends down to approximately an elevation of 643 to 650 feet msl, at which point it is underlain by a lower sand that contains significant amounts of silt and clay.

The lower sand overlies Niagaran Series dolomite bedrock of Silurian age. The upper weathered portion of the Silurian dolomite is encountered at an elevation of approximately 630 msl. The competent dolomitic bedrock surface occurs at approximately 620 to 625 feet msl.

1.3.3 Hydrogeology and Contaminant Migration

Recent investigations in the area around the former TCE fill pipe have resulted in the development of cross-sections SA-1/SA-1' and SA-2/SA-2' in Figures 5 and 6, respectively. Soil analytical results for investigations taking place prior to February 2001 are summarized in Figures 7A through 7H. More detailed investigation of the contamination in the source area near the TCE fill pipe was performed during the spring and summer of 2001. The results of these investigative efforts have been summarized in cross-sections SA-1/SA-1' and SA-2/SA-2.' The location of these cross-sections is identified in Figure 4. Figures 8 and 9 illustrate the occurrence and variability of TCE and cis-1,2-dichloroethene (cis-1,2-DCE) concentrations in the subsurface in the near vicinity of the TCE fill pipe.

Figures 8 and 9 and groundwater monitoring in the vicinity of the former TCE fill pipe indicate that contaminants originating from spills in this area migrate down through the upper silty clay glacial till to the mass waste sand and gravel. In the process of migrating vertically through the upper silty clay till, the TCE has migrated laterally to some degree. This can be observed through a review of Figures 7A through 7E. The seemingly erratic occurrence of TCE to the west onto the MetCoil property away from the spill area is likely to be the result of migration along coarser-grained lithologies or fractures that are not lateral extensive to any great degree. Throughout all the field data collection efforts, the general practice has been to obtain samples for laboratory analysis exhibiting the highest field screening levels by photoionization detector. This would tend to identify the most elevated occurrence of contamination in the subsurface. However, while an expanse of the contamination to the west away from the source area can be observed in Figures 7A through 7E, the most significant mass of contamination still exists in close proximity to the former TCE fill pipe. This can be observed through a review of the analytical results from soil samples acquired in boring CSB-1201 and monitoring well MW-1108S, located in close proximity to the former TCE fill pipe. Some of the

concentrations of TCE from soil samples in this area indicate the presence of pure phase TCE.

Precipitation that infiltrates the surficial soils in the vicinity of the source area does migrate laterally, as is evident by the lateral spreading of TCE away from the former TCE fill pipe area in Figures 7A through 7E. However, after some horizontal migration, the infiltrating precipitation moves vertically through the upper silty clay till to reach the mass waste sand and gravel. In the process of migrating through the upper silty clay till, contamination is partitioned into the infiltrating soil water. This vertical migration of soil water from upper silty clay till to the mass waste sand and gravel appears to have distributed fairly uniform concentrations of TCE throughout the mass waste unit everywhere in the vicinity of contamination occurrence in the overlying upper silty clay till, and not outside this area. This would imply, as would be expected due to its increased permeability, that migration in the mass waste sand and gravel is predominantly vertical.

Contaminated soil water migrating vertically through the mass waste sand and gravel unit in the vicinity of the former TCE fill pipe ultimately encounters the lower silty clay till unit at an elevation of approximately 660 feet msl. At no time during any of the borings in the vicinity of the source area has an accumulation of groundwater in the mass waste sand and gravel on top of the lower silty clay till been observed. Instead, it appears that infiltrating soil water that moved down through the contaminated surficial soils around the source area encounters this lower silty clay till and migrates laterally along its surface. It appears that the surface of the lower silty clay till slopes to the west toward the Ogden Corporate Center property. It also appears that some migration along this surface has occurred toward the southwest to the vicinity of monitoring well MW-500D.

Once the upper surface of the lower silty clay till slopes below an elevation of approximately 655 feet msl, a water table condition occurs within the coarse grain lithologies of the mass waste unit. The occurrence of a water table condition within the

mass waste unit on top of the lower silty clay can be observed in monitoring well MW-522 to the west toward the Ogden Corporate Center property. Recent sample results from this monitoring well recently exhibited concentrations of 273 micrograms per liter (µg/L) of TCE and 57 µg/L of cis-1,2-DCE. The impacts of the runoff of contaminated soil water along the surface of the lower silty clay till toward the west can be observed in the soil sample obtained from the upper surface of this lower till in boring SB-807. This soil sample, acquired from 48 to 50 feet in depth, exhibited a concentration of 51 milligrams per kilogram (mg/kg) of TCE.

Migration of contaminated soil water through the lower silty clay till to the lower sand in the vicinity of the source area has not been observed in investigations to date. A review of the TCE soil concentrations through the vertical thickness in the lower till on cross-section in Figures 8 and 9 indicate that elevated concentrations of TCE occur along the upper surface of the unit but dissipate significantly toward the base of the unit. Soil sampling in the lower sand unit and groundwater sampling from monitoring well MW-1108S, completed in the lower sand unit in the source area, have not detected any occurrence of TCE.

2.0 SOIL REMEDIATION EVALUATION

2.1 SURFICIAL SILTY CLAY TILL

A review of the TCE concentrations depicted in cross-section SA-1 to SA-1' in Figure 8 indicates that separate phase TCE exists in the soils immediately in the area of the former TCE fill pipe. Borings CSB-1201 and MW-1108S are located immediately adjacent to the former fill pipe. These elevated TCE soil concentrations appear to exist to a depth of approximately 20 feet. The elevated TCE contamination occurrence in this area is logical since the hose connection losses from the TCE delivery truck and the losses from the fill pipe overfills would have been expected to have occurred over this area.

One means by which to evaluate the source area is to estimate the mass of TCE present in the surficial silty clay till over certain portions of the source area. Figure 10 presents an irregular-shaped area where concentrations of TCE in the subsurface generally occur at concentrations of 25 mg/kg or higher. The irregular-shaped source area in Figure 10 is then subdivided into 10 smaller areas based on the distribution of borings across the source area. This allows an analysis of the mass of TCE that exists in each subdivided area based on the average of the laboratory analyses from that area. The average concentration attributed to each of the 10 subdivided areas by depth in the silty clay glacial till is presented in Table 1. Once the soil analysis is segregated by depth and averaged over that depth interval for each subdivision area, then the mass contribution from each area can be evaluated. Table 2 presents the results of this mass contribution evaluation by area and depth across the area near the former TCE fill pipe.

The analytical evaluation presented in Table 2 appears to corroborate the visual observations, when reviewing Figure 8, that a great portion of the mass of TCE in the subsurface exists in the shallow silty clay glacial till immediately in vicinity of the former TCE fill pipe. On a mass basis, it appears that approximately 79% of all the TCE mass in

the subsurface soils in the near vicinity of the fill pipe exists in the upper 20 feet of what has been identified as Area 5.

As a result of the analysis and observations identified above, Lockformer will excavate and remove for offsite disposal the glacial till in Area 5 to a depth of 20 feet. The removal of this material will alleviate, to the extent practicable, the concern of separate phase TCE still existing in soils of the source area. This action will result in the excavation and offsite disposal of at least 710 cubic yards or approximately 1,070 tons of soil that exist in Area 5.

2.2 MASS WASTE SAND AND GRAVEL

As described in the hydrogeology discussion provided in Section 1.3.3, the increased permeabilities associated with the mass waste sand and gravel unit have been responsible for vertical migration of elevated concentrations of TCE to the shallow, glaciofluvial groundwater that occurs in areas away from the source area across the site. The degree to which the mass waste sand and gravel has been impacted by releases occurring at the source area can be reviewed in Figure 7F. Lockformer will remediate contaminated soils in the mass waste sand and gravel unit utilizing a dual phase extraction system consisting of soil vapor extraction (SVE) and groundwater withdrawl. Contaminated vapors removed from the subsurface during vapor extraction efforts will be treated by utilizing activated carbon prior to discharge to the atmosphere. Further details regarding the installation and operation of the dual phase system area provided in Section 4.2 of this work plan.

3.0 SITE MOBILIZATION

Excavation activities related to the Area 5 removal will be initiated within 60 days of the approval of this RAP by the USEPA. It is anticipated that the SVE system installation will be initiated within 30 days of the completion of the Area 5 backfilling.

3.1 SITE SAFETY

A copy of the Health and Safety Plan (HASP) for the Lockformer site is provided in Attachment A.

3.2 PRE-WORK MEETING

Site safety orientation/training meetings (briefings) will be convened (1) before the field team begins work at the site; (2) when there are modifications to the HASP that are applicable to the field personnel; and (3) when additional personnel or subcontractors begin work. Meetings will be attended by personnel involved in carrying out the project and will be presided over by the SHSO or his/her designee.

The meeting agenda will include the following minimum activities:

- Review the HASP with the attendees.
- Distribute any HASP modifications.
- Collect the attendees' signatures acknowledging receipt and understanding of the site and HASP and their agreement to comply with the plan (Tailgate Meeting Minutes Form, Attachment A).

3.3 SITE CONTROL MEASURES

Site control will be implemented by installing orange snow-fence around the entire working area. This area will extend at least as far from the working zone as the clean zone perimeter identified in the HASP. The orange snow-fencing will prohibit casual access to the working area.

3.4 SITE PREPARATION

The entire parking lot area west of the Lockformer manufacturing building and south of the offices will need to be used for excavation, loading of trucks, and staging of trucks during the removal operation. As a result, the area on the north end of the MetCoil property will need to be mowed and graded (to the extent necessary) to accommodate parking of employees of the manufacturing facility.

3.5 EMERGENCY RESPONSE CONTINGENCY PLAN

Emergency response procedures related to medical emergencies, fire and explosion, chemical exposure, and unforeseen circumstances are discussed in Section 5.0 of the HASP.

4.0 SCOPE OF WORK

The scope of work associated with this RAP consists of a combination of remedial techniques that will be applied to the various unsaturated lithologies in and around the source area associated with the former TCE fill pipe. The lithologies of concern consist of the upper silty clay till that underlies the source area to approximately 20 feet below ground surface (bgs) and the mass waste sand and gravel that underlies the source area from approximately 30 feet bgs to 46 feet bgs.

Excavation and removal techniques will be used to address highly contaminated soil that exists in the upper zone. Dual phase extraction will be used to remove residual contamination that exists in the vicinity of the TCE fill pipe in the upper till and mass waste unit that has the potential to impact site groundwater.

4.1 REMEDIAL EXCAVATION

Remedial activities in the upper silty clay till will consist of the removal by excavation of Area 5 in Figure 10 to a depth of 20 feet. The soils in this area to a depth of 20 feet contain TCE in separate phase. The material will be directly loaded and transported offsite for treatment, followed by land disposal as hazardous waste at a subtitle C facility. The soils will be transported to the Environmental Quality (EQ) Company facility in Wayne, Michigan. Once at the EQ facility, the soils will be treated by chemical oxidation to lower the concentration to below the land disposal restriction limit. After treatment, the soils will then be deposited in the EQ subtitle C land disposal cell.

Due to the proximity of the source area to the site building, the east wall of the excavation will require stabilization to support the structure. The area close to the building also contains water, sanitary sewer, and storm sewer lines. It may be necessary to excavate some shallow soils by hand to avoid damage to these lines.

The final excavation will be backfilled with clean soil containing greater than 50% silt and clay, and compacted. The excavation will be filled with soils that exist onsite that were generated from the Bill Kay Chevrolet retention basin excavation. The excavation side walls will be cut back to the extent necessary to achieve backfill compaction activities. The cut material will be transported offsite to EQ for disposal along with the other soils excavated.

4.2 DUAL PHASE EXTRACTION SYSTEM

The mass waste sand and gravel unit that exists under areas of the upper silty clay till that exhibit elevated concentrations of TCE will be remediated utilizing dual phase extraction techniques. Figure 11 presents the conceptual dual phase extraction system design for the mass waste sand and gravel. The design as depicted includes the installation of 17 dual phase vertical extraction wells into the mass waste sand and gravel, and two dual phase horizontal wells completed at a depth of approximately 15 feet in the silty clay upper glacial till.

Each dual phase, vertical extraction well will function as a SVE recovery well for the mass waste sand and gravel, and a groundwater recovery point for any groundwater collecting on the surface of the lower till in the mass waste sand and gravel. Each dual phase, vertical extraction well will be constructed with a sump at its base that is completed three feet into the upper surface of the lower silty clay glacial till unit. The sumps installed into the upper surface of the lower till will provide for collection of groundwater as it accumulates on a seasonal or intermittent basis. Each of the 17 dual phase, vertical extraction wells will be fitted with a pneumatic pump actuated by a float sensor to discharge as groundwater collects in the sump. The groundwater discharged from these pneumatic pumps will be directed to the equipment building identified in Figure 11 where it will undergo treatment for removal of VOCs by a stacked tray stripper. Upon removal of the VOCs, the water will be discharged to the local POTW via permit.

The 17 vertical dual phase wells will remove contaminants from the mass waste sand and gravel through SVE. A network of gas probe monitoring points will be installed throughout the area of the installation to allow monitoring of the area of influence and degree of pressure drop in the subsurface. If the gas probe monitoring points indicate that any portion of the treatment area does not attain sufficient withdrawal, then additional SVE wells will be installed. A diagram outlining the general design components of each of the vertical dual phase extraction wells is provided in Figure 12.

In addition to the 17 vertical, dual phase extraction wells installed at the site to address contamination occurring in the mass waste sand and gravel, two horizontal dual phase wells will be installed in close proximity to the former TCE fill pipe area to remove contaminants from the silty clay upper till. Each of the two horizontal dual phase extraction wells will have screened intervals of approximately 130 feet in length. Approximately 50 feet of each 130-foot screened interval will be under the Lockformer building. The horizontal screens will be placed approximately 15 feet below the existing grade surface in the vicinity of the TCE fill pipe.

The horizontal wells will be installed utilizing standard horizontal drilling techniques. The horizontal well installation will originate on the MetCoil property, proceed through the TCE fill pipe area, and surface within the Lockformer facility. The high density polyethylene (HDPE) horizontal well pipe will then be installed in the hole by withdrawl of the drilling tools. The horizontal screen in the HDPE will be fabricated in the field by drilling holes in the pipe or by hand slotting. The distribution of the slots will be a function of balancing the nozzle losses to the frictional losses through the pipe. The location where the horizontal, dual phase extraction well screens will be placed is identified in Figure 11.

The horizontal, dual phase extraction wells will be operated by utilizing vacuum from the SVE system. Liquids that are pumped will be directed into the knock out pot on the SVE

system and routed to the stacked tray stripper unit with other groundwater collected from the mass waste sand and gravel. When not pumping groundwater, the horizontal, dual phase wells will discharge air to the same activated carbon units that are used for the SVE system in the mass waste sand and gravel.

A high airflow/low vacuum unit will be installed and operated until the mass recovery of contaminants is negligible due to asymptotic declines in soil gas concentrations in both the mass waste sand and gravel, and the silty clay upper till. After that time, the system will be operated on an intermittent basis. The unit will consist of a knock out pot, an automatic drain pump, electrical enclosure, process piping, an air dilution valve (ADV), an airflow sensor with electronic display, pressure and vacuum gauges, sample ports, and an automatic shutoff device. The knock out pot will include three float switches and an automatic drain pump that will be placed prior to the inlet of the blower/vacuum pump. The SVE unit will also include all appropriately sized process piping and electrical connections. The general layout of facility piping and the anticipated location of the process equipment building is illustrated in Figure 11.

The SVE units will require 100 ampere, 3-phase, 230/460 volt power. All blower/pump motors, sensors, electrical controls mounted or near piping, and confined enclosures (i.e., covers for equipment, sensor, etc.) will be wired according to Class I, Division 2 electrical standards by a licensed electrician.

The SVE unit and other equipment will be positioned in the treatment building to allow sufficient room to walk around each component of the remediation system. The inlet of the SVE unit will be connected to the extraction well manifold system using 4-inch ID, Schedule 40 PVC pipe and couplings. The extraction well manifold will consist of vertical process pipes connected to individual extraction wells and/or well chases. The vertical process pipes will include ball valves, sample ports, and measurement access ports. A discharge stack consisting of appropriately sized metal or Schedule 80 PVC

pipe will be installed at the vacuum blower/pump outlet, secured, and brought through the ceiling of the treatment building. The height of the discharge stack will be stipulated on the air discharge permit.

The SVE unit, water treatment system, process manifold, and associated equipment will be installed in an appropriately sized treatment building. The treatment building will include an asphalt or concrete pad, wood frame with pitched roof, roof vent, sky light, and a minimum 8.5-foot garage door with lock. The treatment building will be insulated and will also include a heater, thermostat, and overhead light. The circuit box will be installed on the outside of the buildings. The treatment building will also include an outdoor and indoor outlet. All electrical connections and outlets will be installed according to electrical standards. Construction of the treatment building will require a building permit.

A construction and operation permit application will be prepared and submitted to the IEPA Air Section for review and approval prior to SVE system installation. The air permit application will include all necessary process drawings, air emission calculations, and equipment specifications. The estimated air emissions will be based on the maximum concentration of contaminants present in the soil, the calculated partitioned vapor phase concentration, and the anticipated volumetric air withdrawal rate. The air permit will stipulate that activated carbon be used to treat the SVE system air stream prior to discharge to the atmosphere. The air permit review and approval process is expected to take approximately one month after submittal to IEPA.

4.3 HISTORICAL DRAINAGEWAY SAMPLING

Figure 13 is an aerial photograph of the Lockformer site and vicinity on April 9, 1970 and was provided by the USEPA. Lockformer will perform soil sampling along the historical drainageways depicted on this photo at the locations marked by the red dots.

The intent of this sampling will be to determine if any contamination has been transported away from the area of the facility building through these drainageways. At each sampling location, continuous soil samples will be acquired by a hydraulic probe unit (HPU) to a depth of 16 feet. Upon acquisition, each sample will undergo headspace screening to determine the presence of organic vapors by a photoionization detector (PID). Those samples exhibiting headspace screening values greater than 5 ppm will be preserved by EPA Method 5035 and submitted for laboratory analysis by EPA method 8260b. A general description of the sampling locations is as follows:

- One sampling location immediately in front of the northeast loading dock.
- Two sampling locations in the north-south drainage ditch leading from the southeast corner of the Lockformer Building.
- Three sampling locations along an old northeast-southwest trending drainage swale on the MetCoil property.
- Four sampling locations along the north-south drainage ditch between the Lockformer property and the MetCoil property, and along the West Avenue right-of-way.

4.4 VAPOR DEGREASER REMOVAL

Lockformer will remove the mechanical vapor degreasing unit from its manufacturing facility. The degreasing unit is in good operating condition, and as such, will be sold for use at another manufacturing location, or will be sold for scrap.

4.5 VERIFICATION SOIL SAMPLING

Upon completion of SVE efforts involving the mass waste sand and gravel unit, discrete soil samples will be collected to identify the level to which soils have been remediated. Soil gas readings acquired from the network of vapor monitoring points will also be acquired at that time to allow correlation to soil concentrations determined through soil sample analysis. This data will allow the interpretation of vapor monitoring point

concentration data in the future to dictate the regularity of pulse operation of the SVE system.

All soil samples will be preserved on ice and transported under proper chain of custody protocol to First Environmental Laboratory, Inc., located in Naperville, Illinois. The samples will be analyzed for the presence of VOCs using SW846 Method 5035/8260. Laboratory analysis of verification soil samples collected during remedial activities will provide Level III quality, as defined in the IEPA Site Remediation Program Analytical Quality Assurance Program.

4.5.1 QA/QC Samples

QA/QC samples will be collected and analyzed in conjunction with the verification samples. The types of QA/QC samples and their frequencies are described below.

4.5.1.1 Trip Blank

A trip blank is a water sample prepared by the laboratory that is transported to the sampling site and is handled in the same manner as other samples, except that it remains unopened, and then is returned to the laboratory for analysis to determine QA/QC of sample handling procedures. One trip blank is included in each cooler containing samples for VOC analysis.

4.5.1.2 Field Duplicate

A field duplicate is a blind duplicate sample taken in the field and sent to the laboratory for analysis. The results will provide some indication of the homogeneity of the sample's medium and the precision of the laboratory and its equipment. A minimum of one field duplicate will be collected for each ten or fewer organic samples of groundwater.

4.5.1.3 MS/MSD

A MS/MSD is a separate sample or additional sample volume (the samples will be split at the laboratory to provide the MS duplicate) collected in the field and sent to the laboratory for analysis. The results provide information about the effect of sample matrix on the digestion and measurement methodology. MS/MSDs will be collected for each 20 or fewer organic groundwater samples. MS/MSDs will not be obtained at the same locations as duplicates.

4.6 MANAGEMENT OF RESIDUAL REMEDIATION-DERIVED MATERIALS

Remediation-derived materials will be generated during multiple phases of the remedial activities including: equipment decontamination, storm water collection (if necessary), soil boring, soil sampling, and residuals from the SVE system (i.e., spent activated carbon). The management of such materials is discussed in Sections 4.4.2 and 4.4.3.

4.6.1 Equipment Decontamination

A decontamination area for remediation equipment will be established at the site. The area will be constructed in a manner that will allow the collection of all decontamination materials. A high-pressure power washer supplied with potable water will be used for decontamination of soil boring/sampling equipment. Prior to entering the site, all appropriate parts of excavation and drilling equipment will be thoroughly washed with a standard commercial soap and clean water to remove soil, oil, and grease. Before initiating excavation and drilling activities and between each drilling location, the appropriate parts of the equipment (including: the backhoe bucket and tracks; split spoons, augers, drill bits, drill rods, core barrels, casings, and any associated tools that enter boreholes) will be high-pressure washed at the decontamination station.

Sampling equipment such as split spoons, bailers, and scoops that will be reused during sampling will be decontaminated between each sampling location or interval (if applicable). This decontamination protocol consists of scrubbing the equipment with an Alconox or comparable solution and tap water wash followed by a distilled water rinse.

Residual soils removed during the equipment decontamination process will be managed with remediation-derived soils as described in Section 4.4.2. Decontamination water and storm water that may accumulate in the excavation will be managed as outlined in Section 4.4.3.

4.6.2 Management of Residual Remediation-Derived Soils

Soil cuttings brought to the surface during drilling activities will be containerized and staged onsite. All containers will be labeled as to their contents and date of origin, pending management offsite.

4.6.3 Management of Residual Remediation-Derived Liquids

Decontamination water and storm water generated during remedial activities will be containerized and staged onsite. All containers will be labeled as to their contents and date of origin, pending management offsite.

5.0 SITE RESTORATION

Site restoration as it relates to the excavation of Area 5 will be implemented immediately upon completion of excavation and removal activities. The excavation will be filled with soils that exist onsite that were generated during the excavation of the Bill Kay Chevrolet retention basin. These soils will contain greater than 50% silt and clay and will be compacted utilizing site excavation equipment. Any subsequent settling of the excavation in the future will be addressed on an as needed basis to prevent increased infiltration of precipitation into the area.

6.0 TIMELINE

Excavation activities related to the Area 5 removal will be initiated within 60 days of the approval of this RAP by the USEPA. Two weeks after approval of this RAP by the USEPA, a construction and operation permit and air permit for the dual phase extraction system installation will be submitted to IEPA for approval. Unless there are permitting issues with IEPA that cause a delay, the dual phase extraction system installation will be initiated within 30 days of the completion of the Area 5 backfilling. It is currently anticipated that the SVE system installation in the mass waste sand and gravel will operate approximately 18 to 24 months before going asymptotic on its mass removal rate. After contaminant recovery through vapor recovery in the mass waste sand and gravel is no longer successful, vapor monitoring of the unit will be initiated on a semi-annual basis. The results of this vapor monitoring will dictate the schedule of pulse operation of the SVE system in the future.

The soil sampling associated with the historic drainageways at the site will begin within 30 days of approval of this work plan by USEPA. The mechanical vapor degreaser will be removed from the Lockformer facility within six-months of the approval of this work plan.

7.0 PROJECT MANAGEMENT

The purpose of the project management section is to describe the project organization and responsibilities of essential individuals for conduct of the Interim RAP. Key individuals and their responsibilities are as follows:

Project Manager

Mr. Ronald B. St. John will serve as the Interim Remedial Action Project Manager. In his role as Project Manager, Mr. St. John will be responsible for coordination of all project activities. He will be responsible for implementing the project plans, as well as scheduling, cost control, and integration of the various technical disciplines required during this project.

Project Quality Control Officer/Coordinator

Mr. William Elwell will serve as the Interim Remedial Action Project Quality Control Officer. Mr. Elwell will provide general oversight and guidance to the field manager. He will review all major technical evaluations and reports. He will coordinate all of the field activities, communication with field personnel, and will serve as the Project Health and Safety Officer.

Field Manager

Mr. Darren Lamsma will serve as the Interim Remedial Action Field Manager.
Mr. Lamsma will be responsible for conducting the Interim Remedial Action field tasks, supervising subcontractors, and serving as the Site Safety Officer for the project.

FIGURES

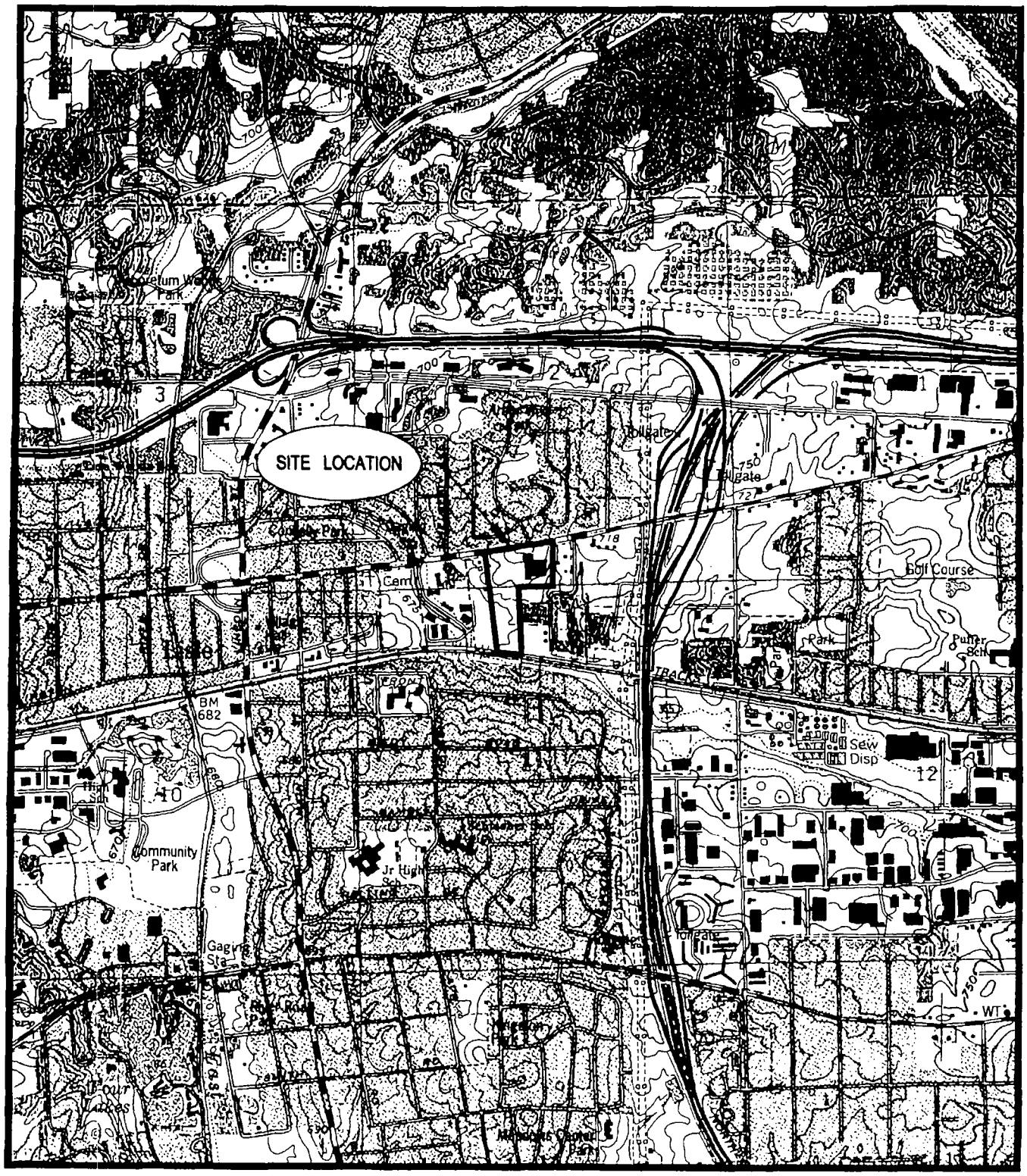
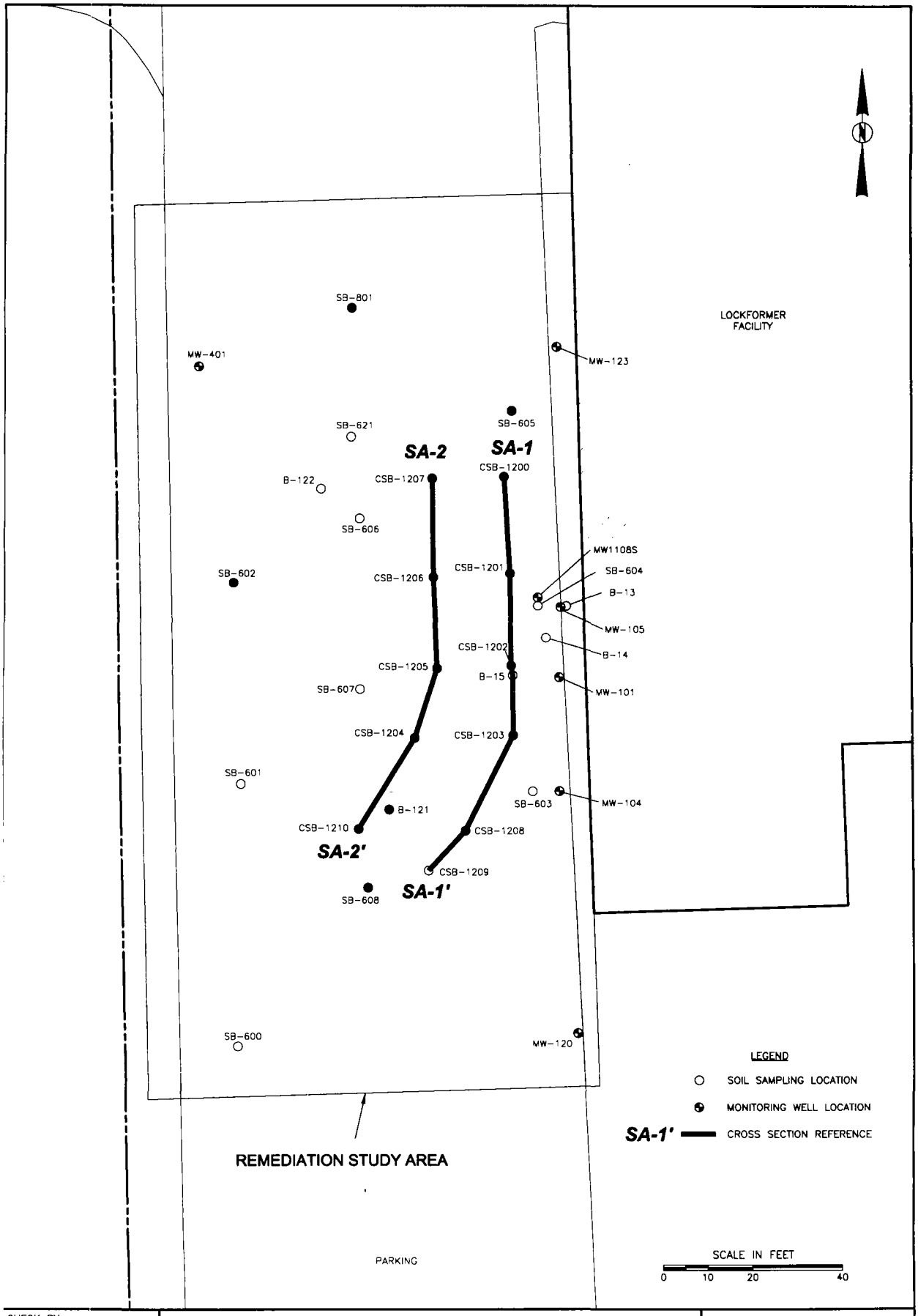


FIGURE 1

SITE LOCATION MAP

THE LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

(SOURCE OF MAP IS USGS 7.5 MINUTE QUADRANGLE MAP, WHEATON, ILLINOIS)



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DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	6526302w
PRJ NO.	65263.01

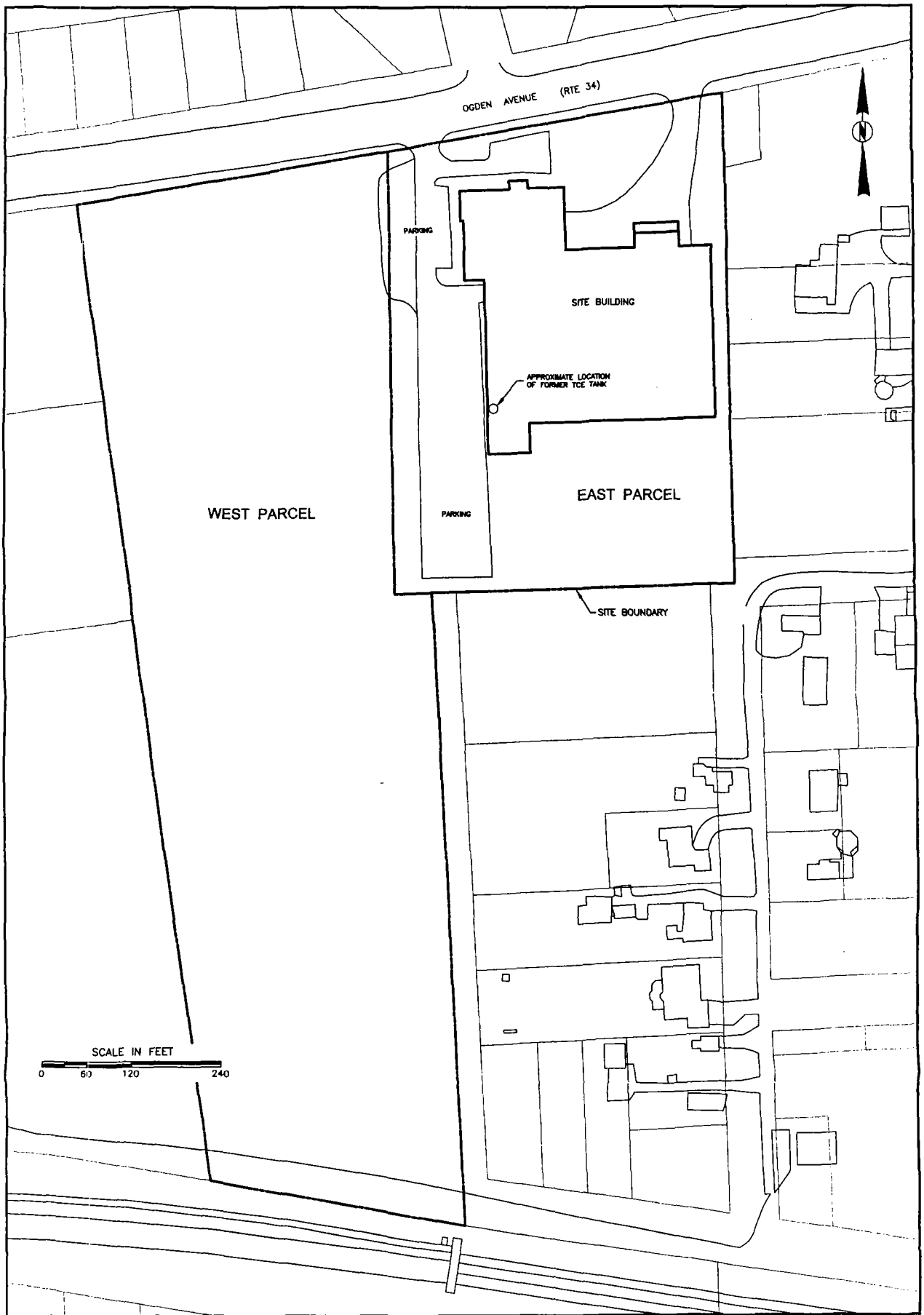
SOIL BORINGS AND WELLS IN THE
VICINITY OF THE TCE FILL PIPE SOURCE AREA

THE LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES
3140 FINLEY ROAD, DOWNERS GROVE, IL 60515

FIGURE 4

SITE TOPOGRAPHIC MAP



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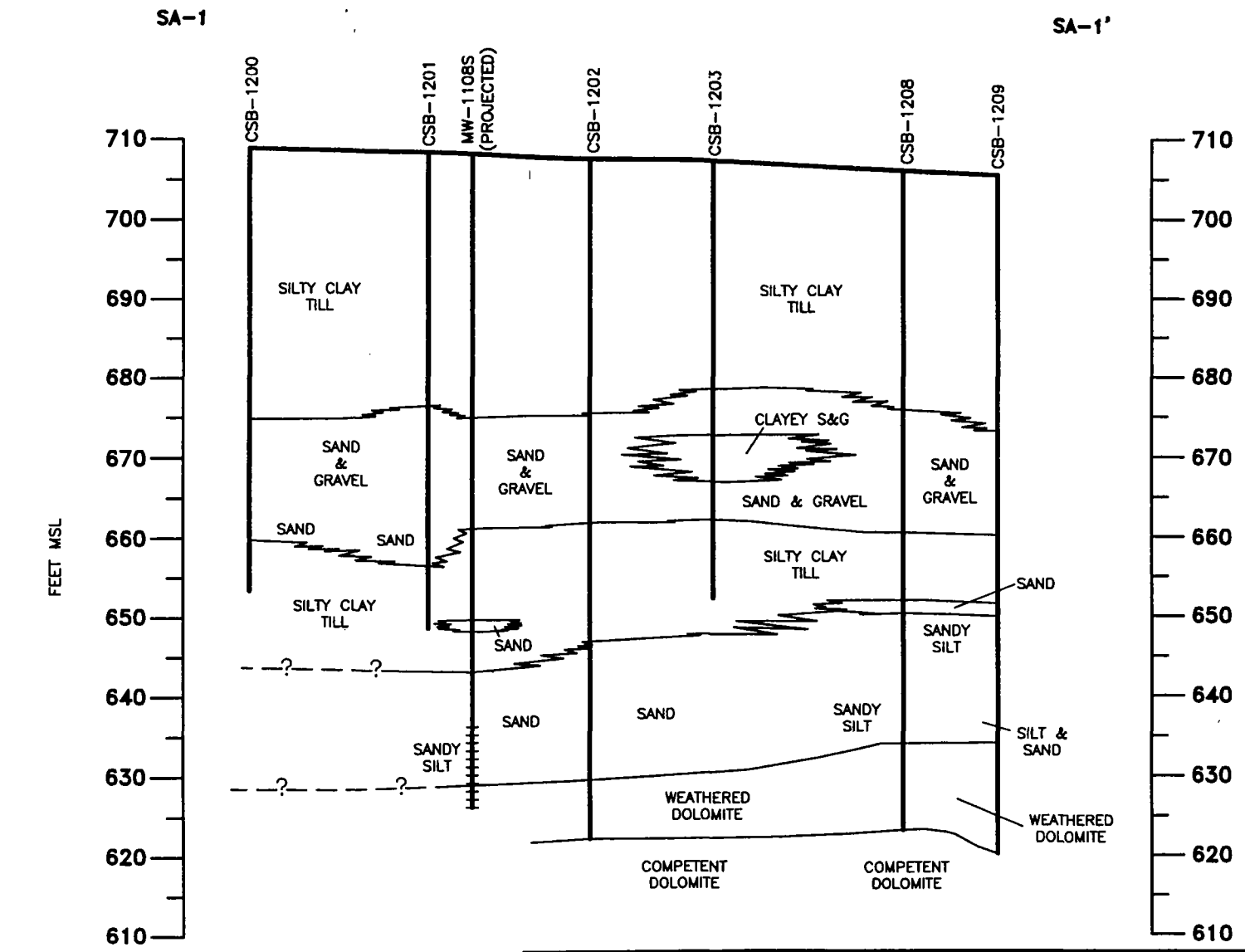
SCALE	AS SHOWN
CAD NO.	6526301K
PRJ NO.	65263.01

SITE LAYOUT MAP

THE LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES
3140 FINLEY ROAD, DOWNERS GROVE, IL 60515

FIGURE 2



HORIZONTAL SCALE IN FEET

0 10 20 40

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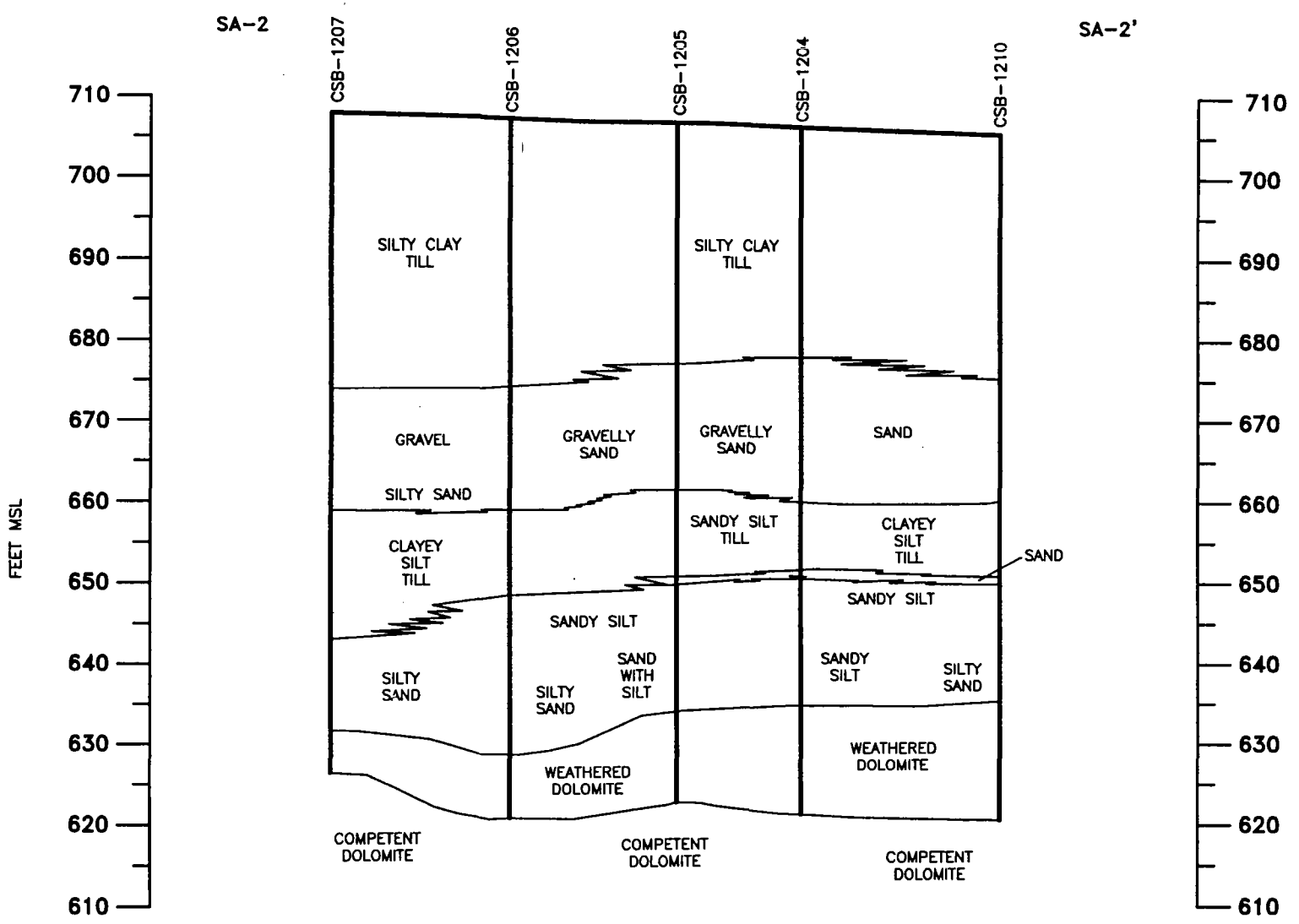
DWN BY	OS
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	6526302u-xsec
PRJ NO.	65263.01

CROSS SECTION "SA-1 – SA-1'"

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE
5



HORIZONTAL SCALE IN FEET

0 10 20 40

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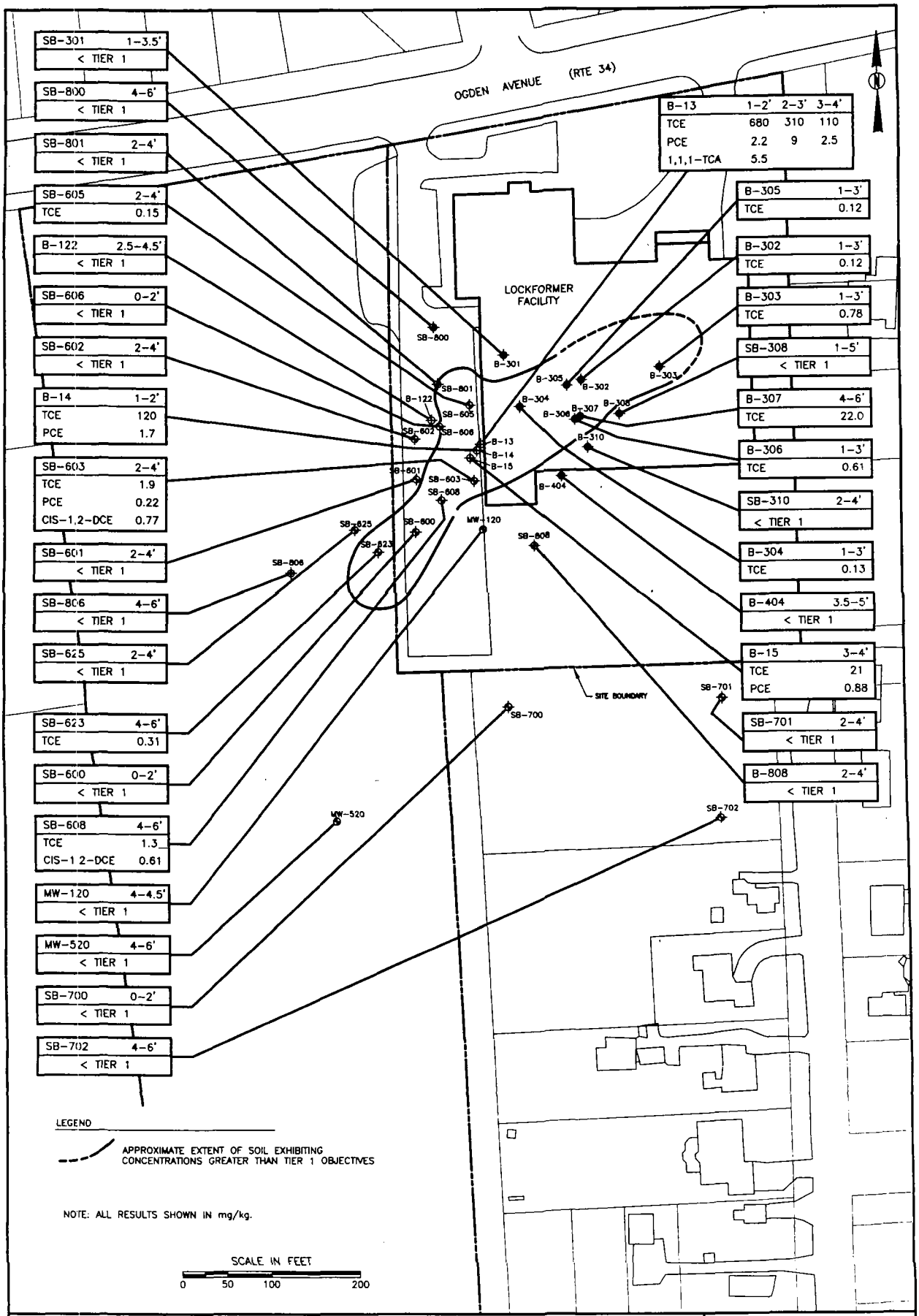
SCALE	AS SHOWN
CAD NO.	6526302v-xsec
PRJ NO.	15-65263

CROSS SECTION "SA-2 – SA-2'"

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE
6



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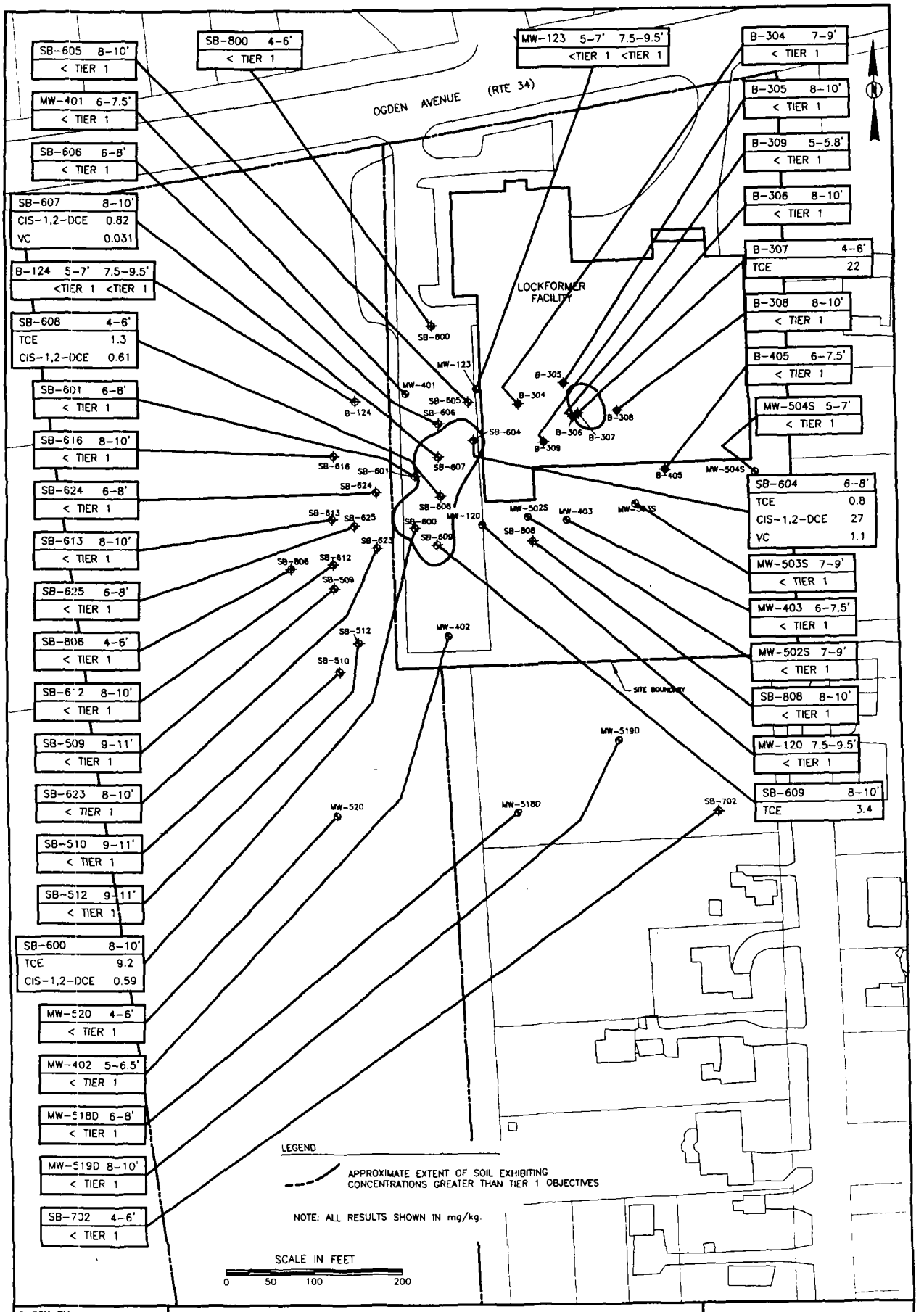
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	65263038
PRJ NO.	65263.01

SOIL SAMPLES IN THE 0-5' DEPTH INTERVAL

THE LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 7A



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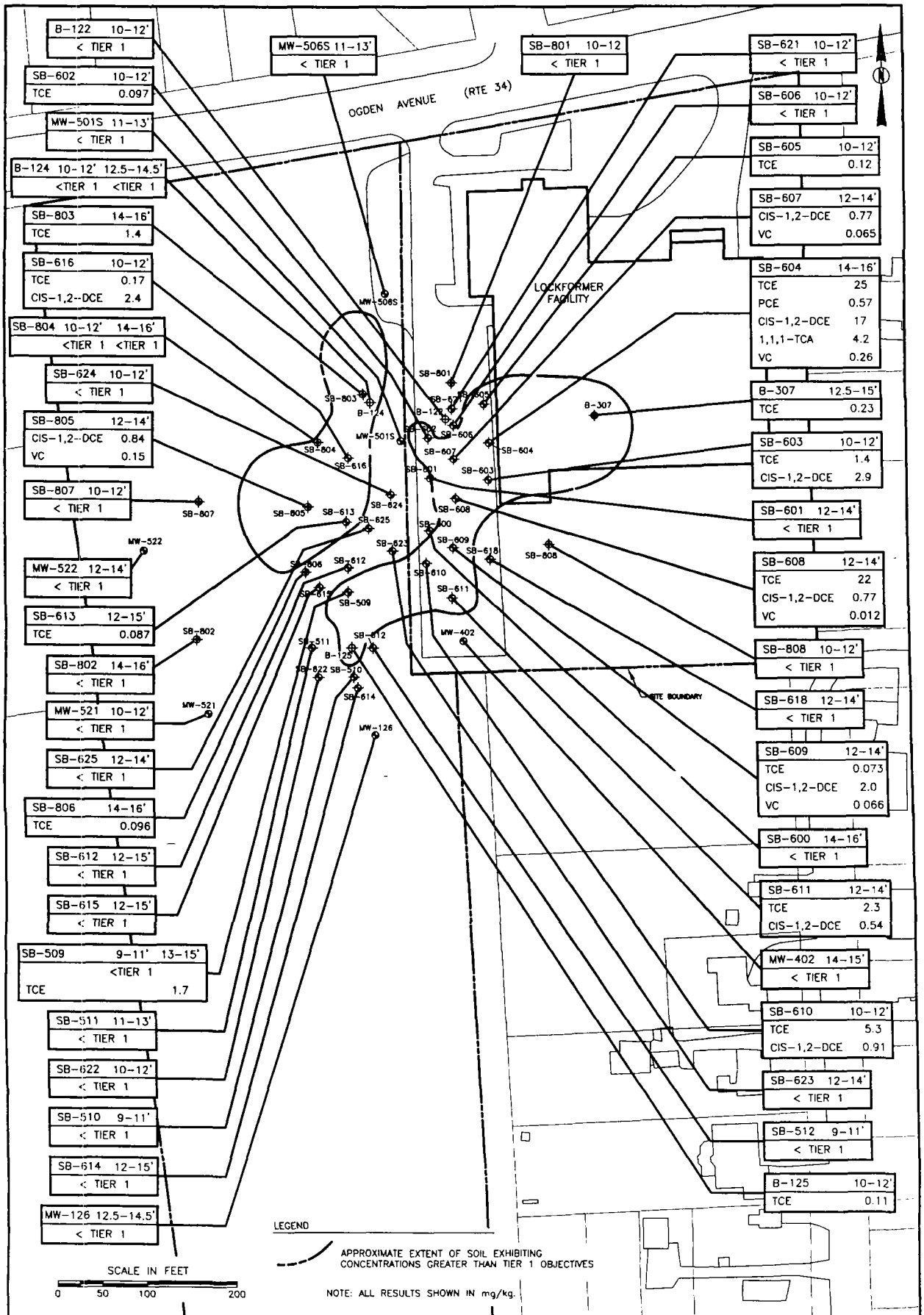
DRAWN BY	JCP
DATE	3-17-01
SCALE	AS SHOWN
CAD NO.	55263078
PRJ NO	55263.01

SOIL SAMPLES IN THE 5-10' DEPTH INTERVAL

THE LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 7B



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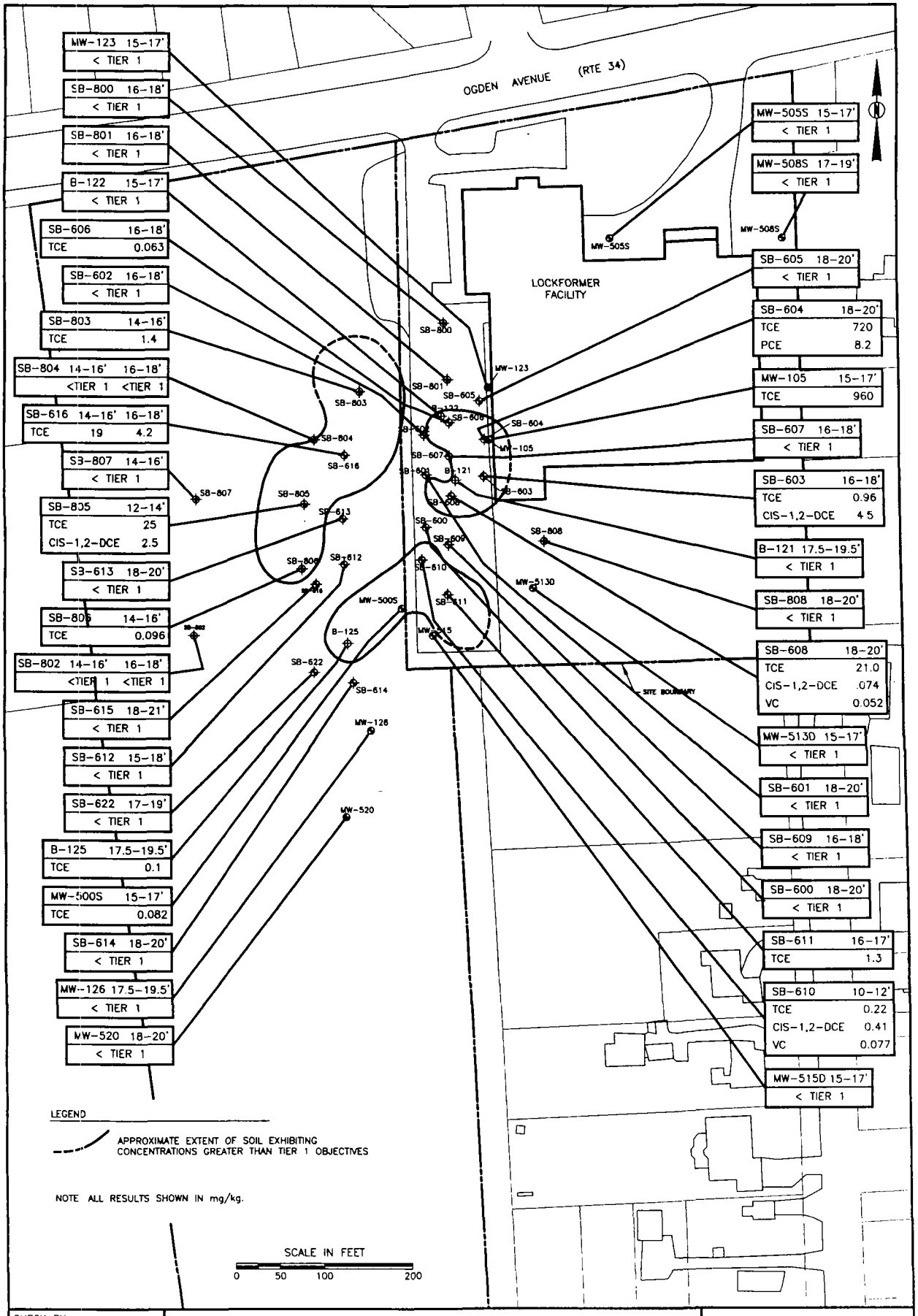
DRAWN BY	BCP
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	65263O7C
PRJ NO	65263.01

SOIL SAMPLES IN THE 10-15' DEPTH INTERVAL

THE LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 7C



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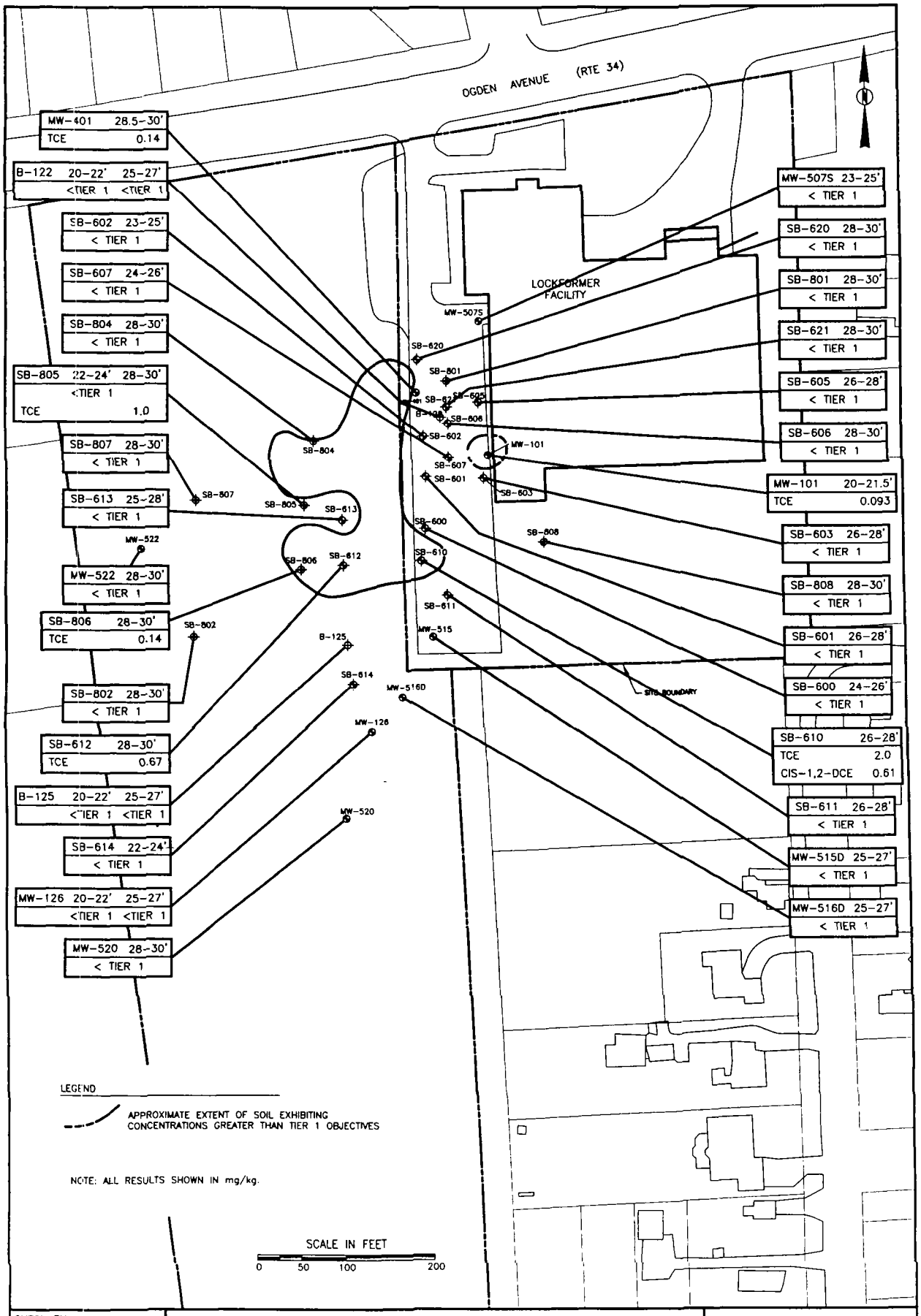
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	65263070
PRJ NO.	65263 01

SOIL SAMPLES IN THE 15-20' DEPTH INTERVAL

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 7D



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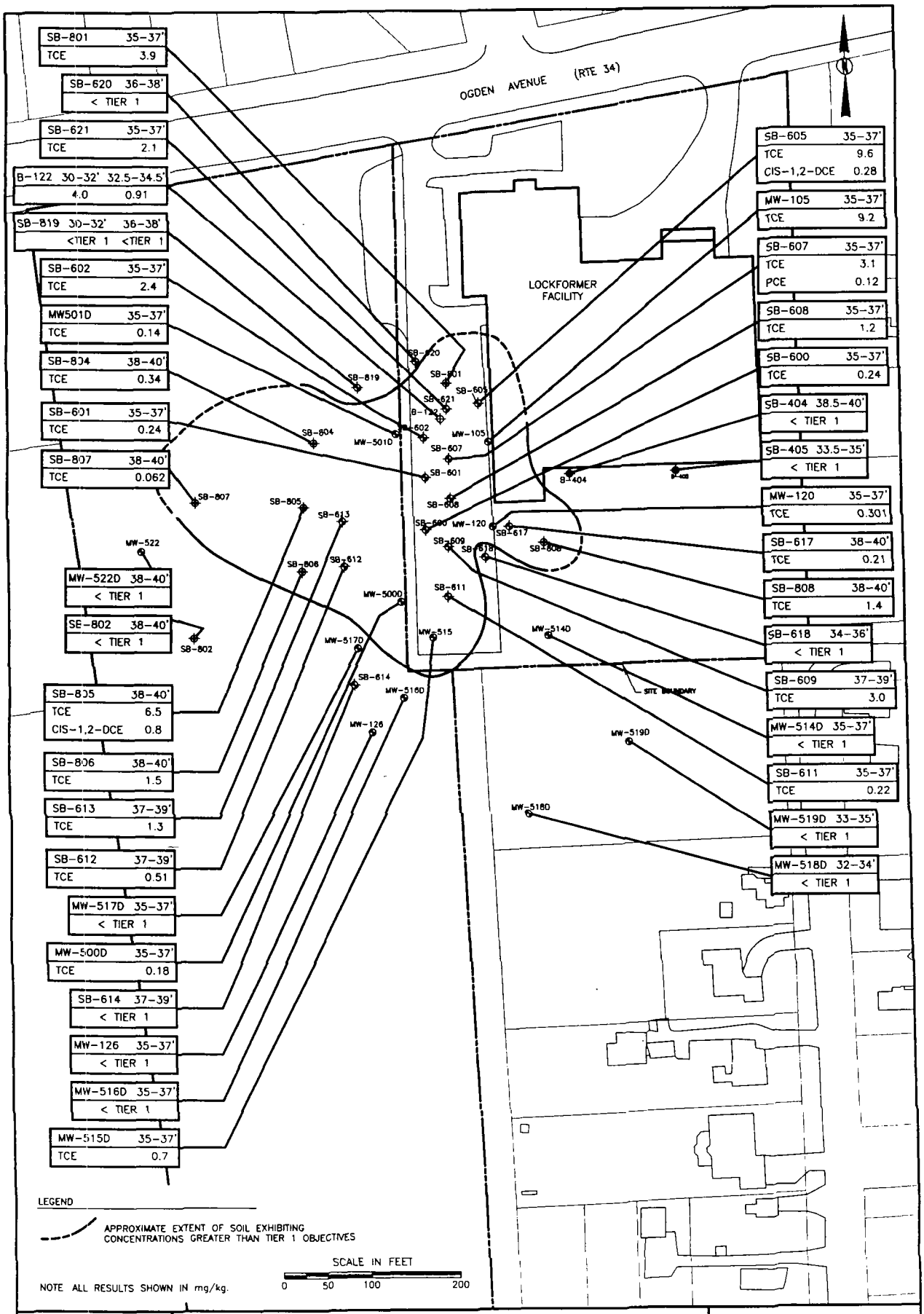
DRAWN BY	BCP
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	65263O7E
PRJ NO.	65263.01

SOIL SAMPLES IN THE 20-30' DEPTH INTERVAL

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 7E



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DATE	8-17-01
SCALE	AS SHOWN
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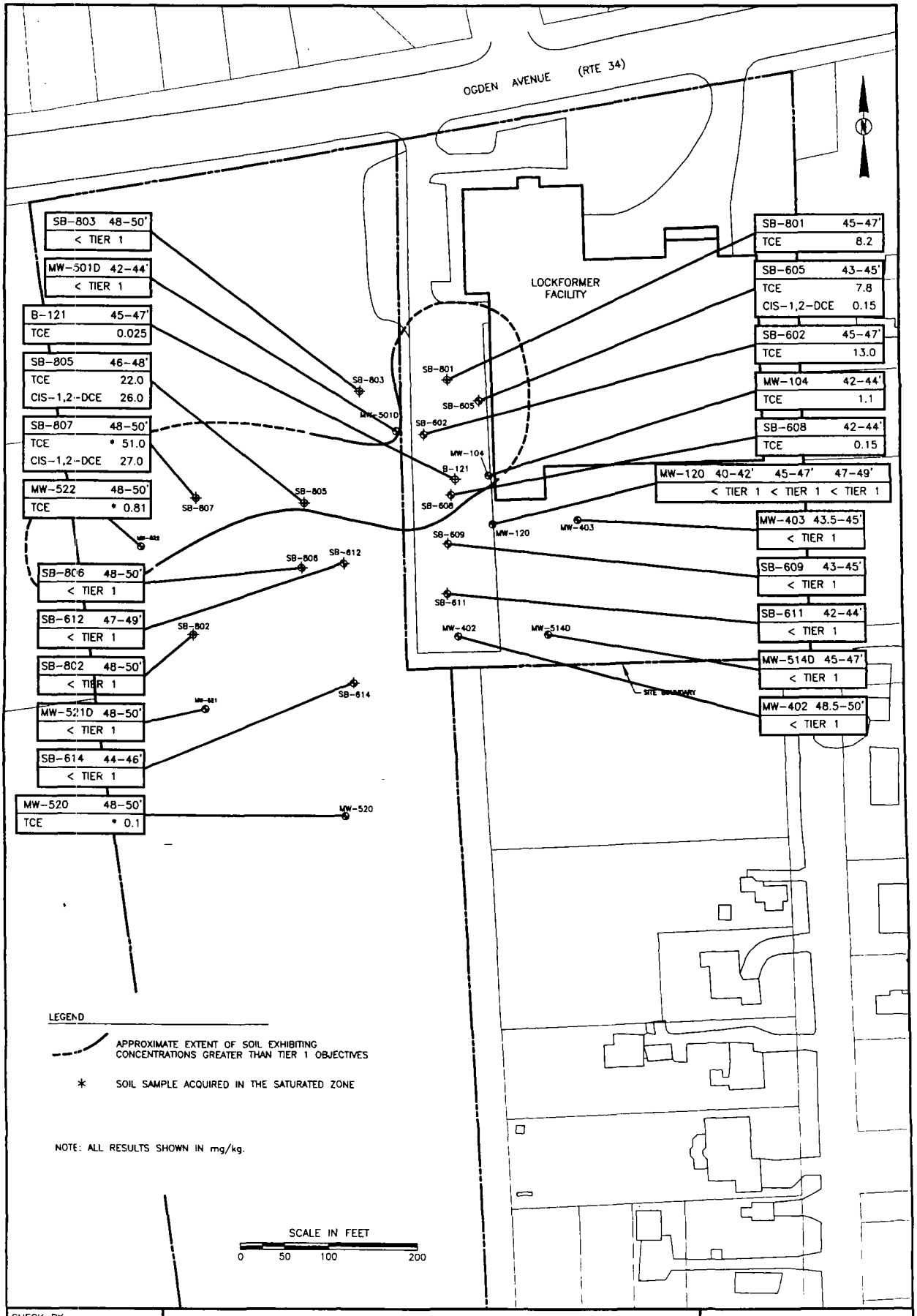
PRJ NO	65263.01

SOIL SAMPLES IN THE 30-40' DEPTH INTERVAL

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 7F



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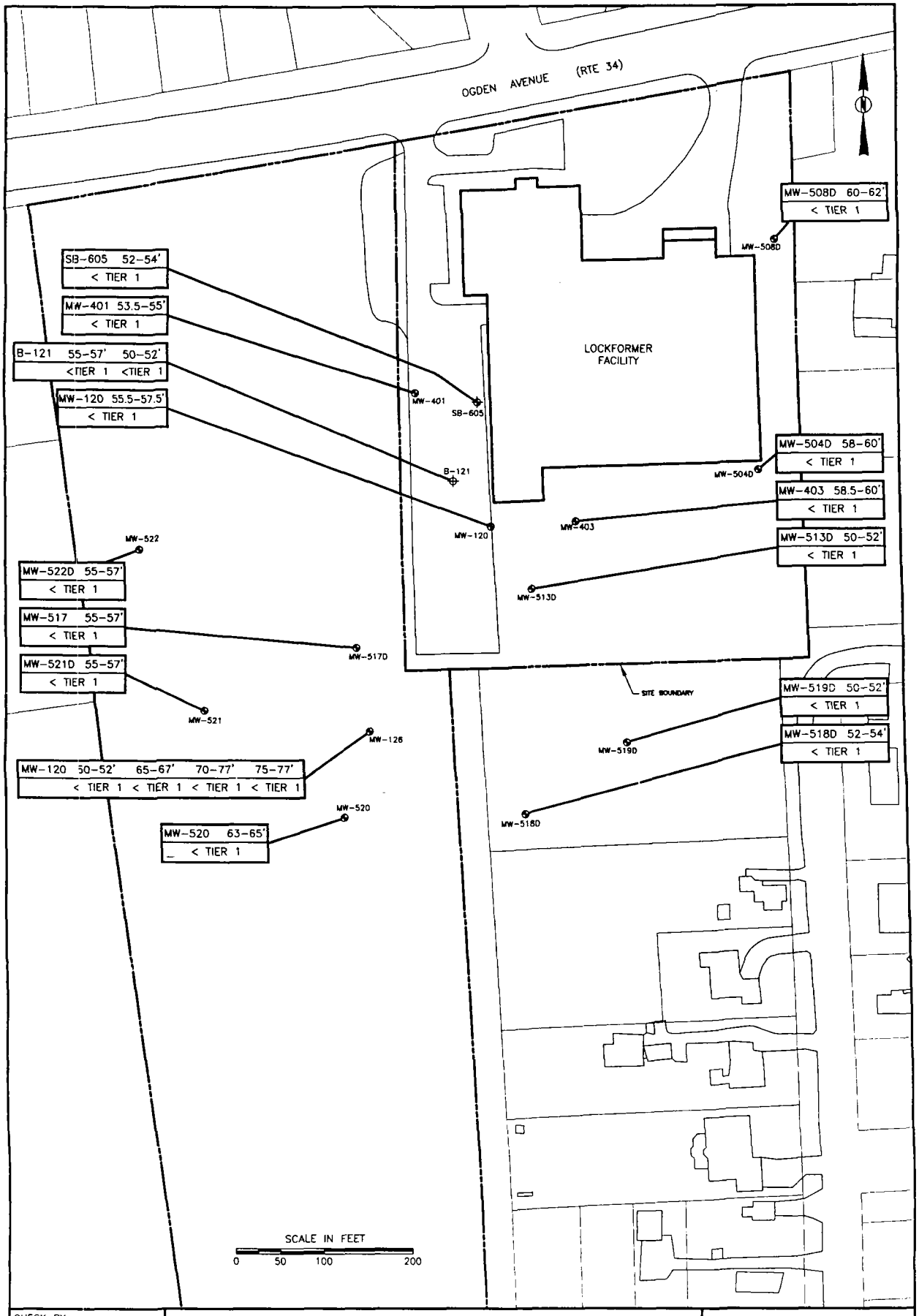
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	6526307G
PRJ NO.	65263 01

SOIL SAMPLES IN THE 40-50' DEPTH INTERVAL

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 7G



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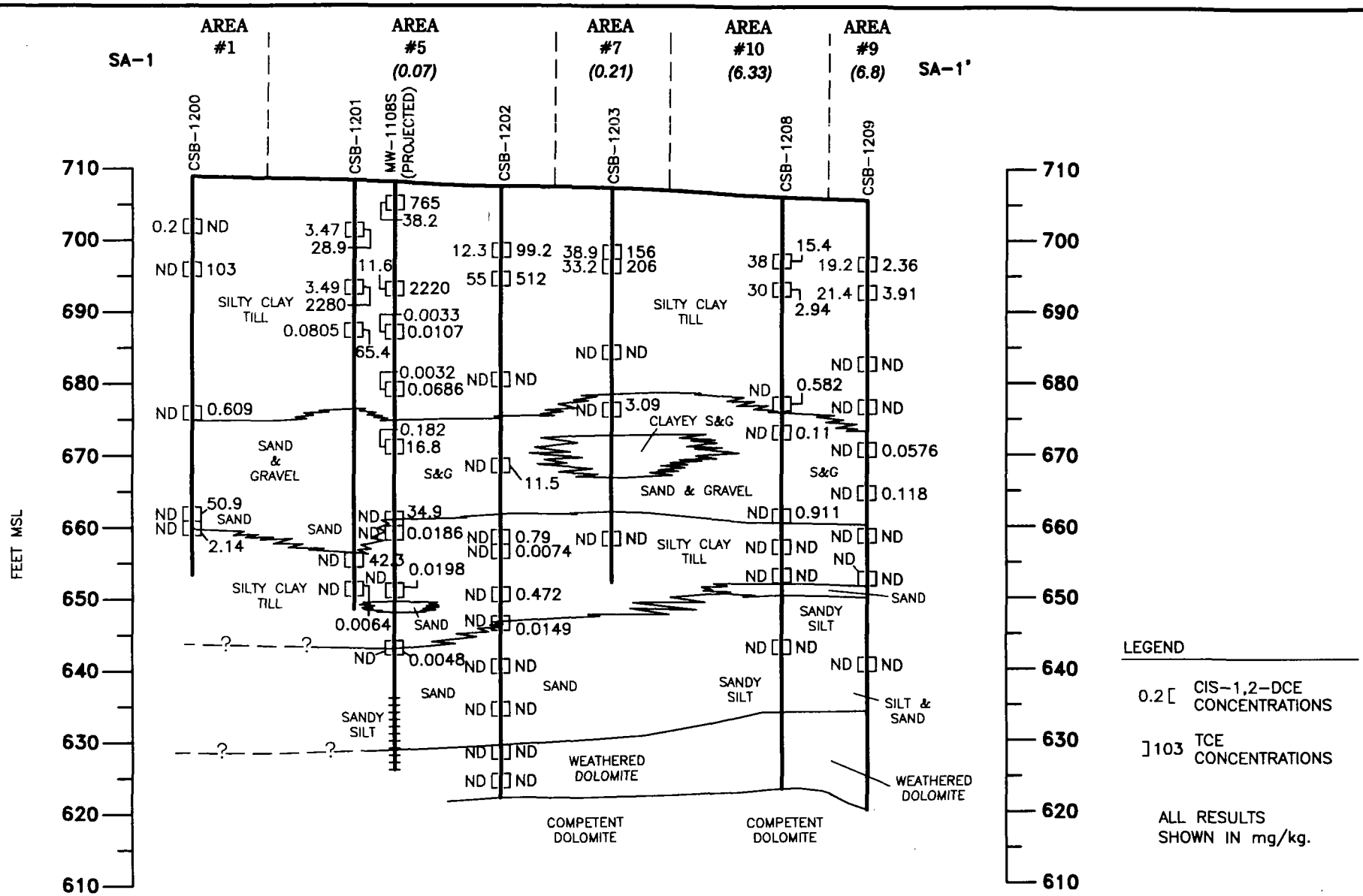
DRAWN BY	BCP
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	6526307H
PRJ NO.	65263.01

SOIL SAMPLES IN THE OVER 50' DEPTH INTERVAL

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 7H



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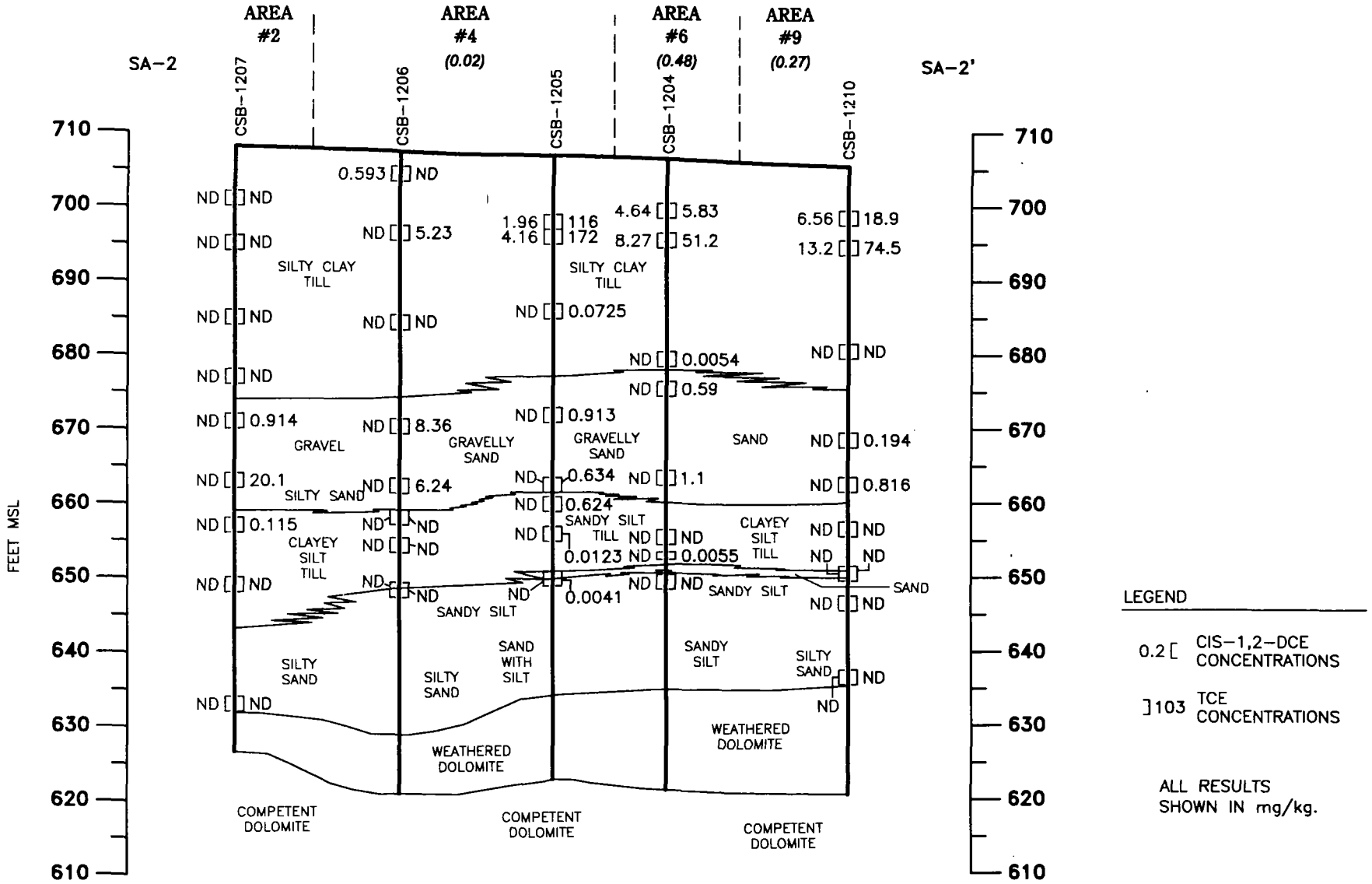
DWN BY	OS/BCP
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	6526302u
PRJ NO.	65263.01

CROSS SECTION "SA-1 - SA-1'"
WITH TCE AND CIS-1,2-DCE SAMPLE RESULTS

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE
8



HORIZONTAL SCALE IN FEET

0 10 20 40

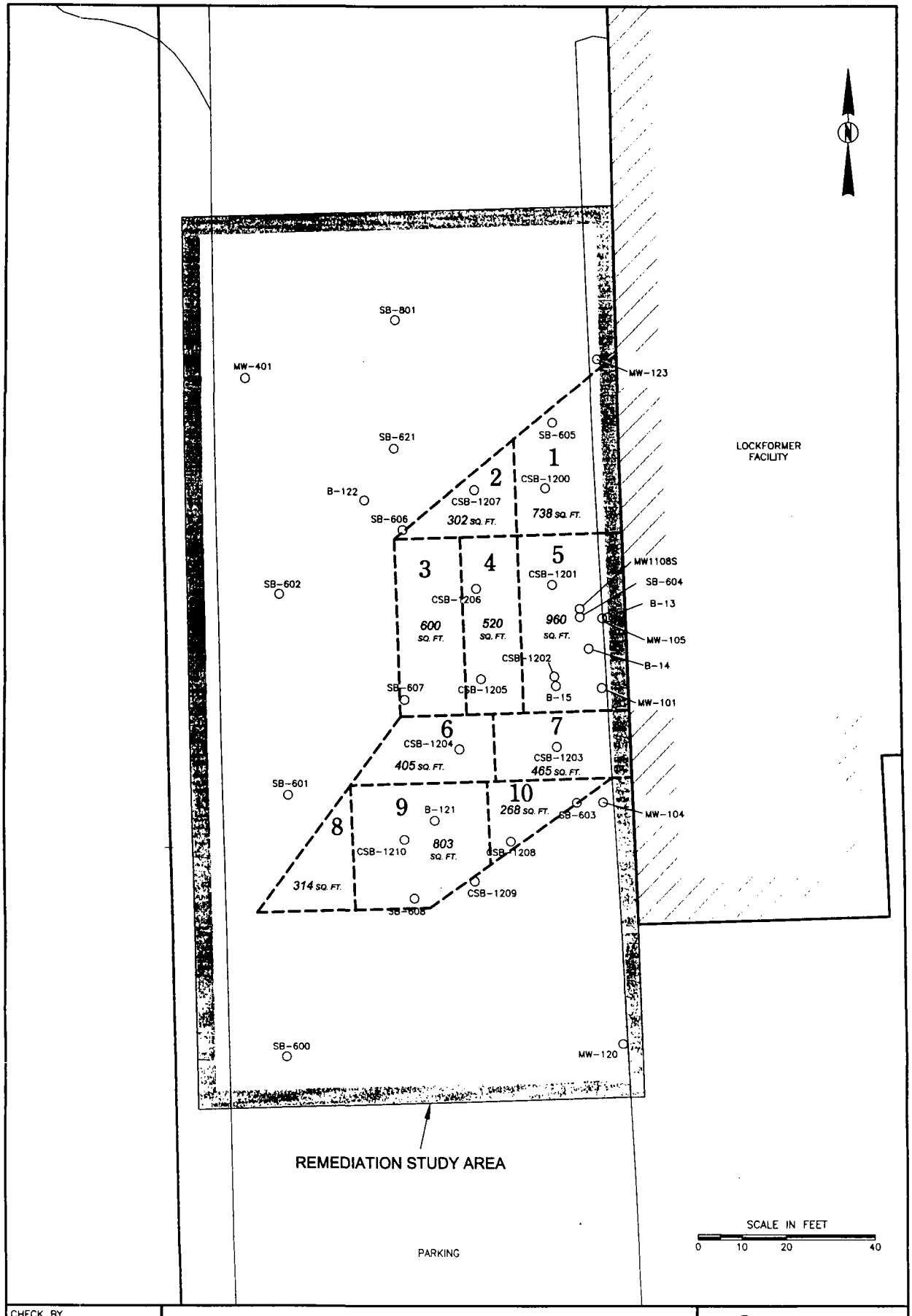
CHK BY	
DWN BY	OS/BCP
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	6526302v
PRJ NO.	15-65263

CROSS SECTION "SA-2 - SA-2'"
WITH TCE AND CIS-1,2-DCE SAMPLE RESULTS

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 9



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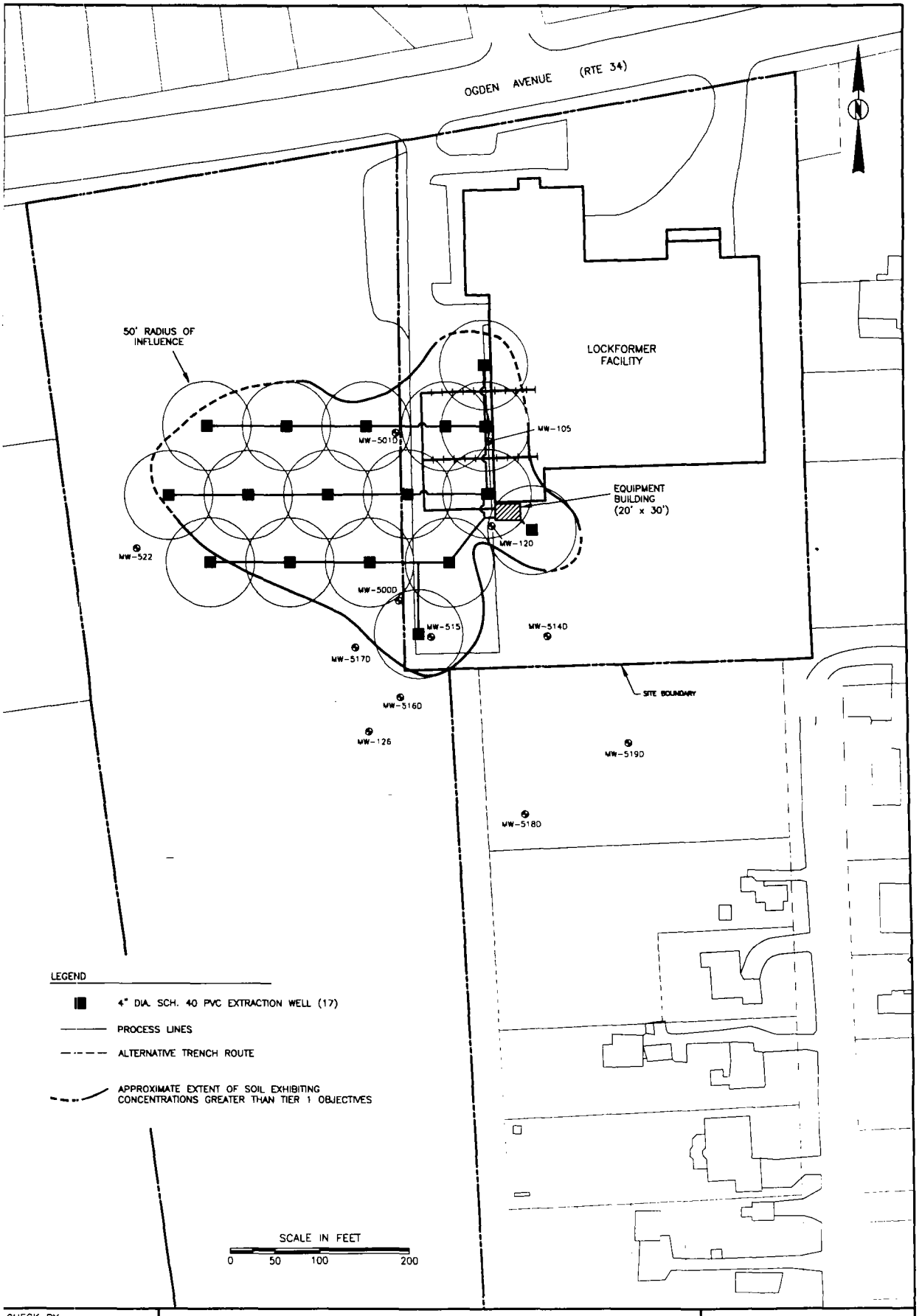
DRAWN BY	BCP
DATE	8-17-01
SCALE	AS SHOWN
CAD NO.	65263O2E
PRJ NO.	65263.01

AREA CONTRIBUTIONS OF TCE NEAR THE FORMER FILL PIPE

THE LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES
3140 FINLEY ROAD, DOWNERS GROVE, IL 60515

FIGURE 10



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DATE	8-23-01
SCALE	AS SHOWN
CAD NO.	6526302x
PRJ NO.	65263.01

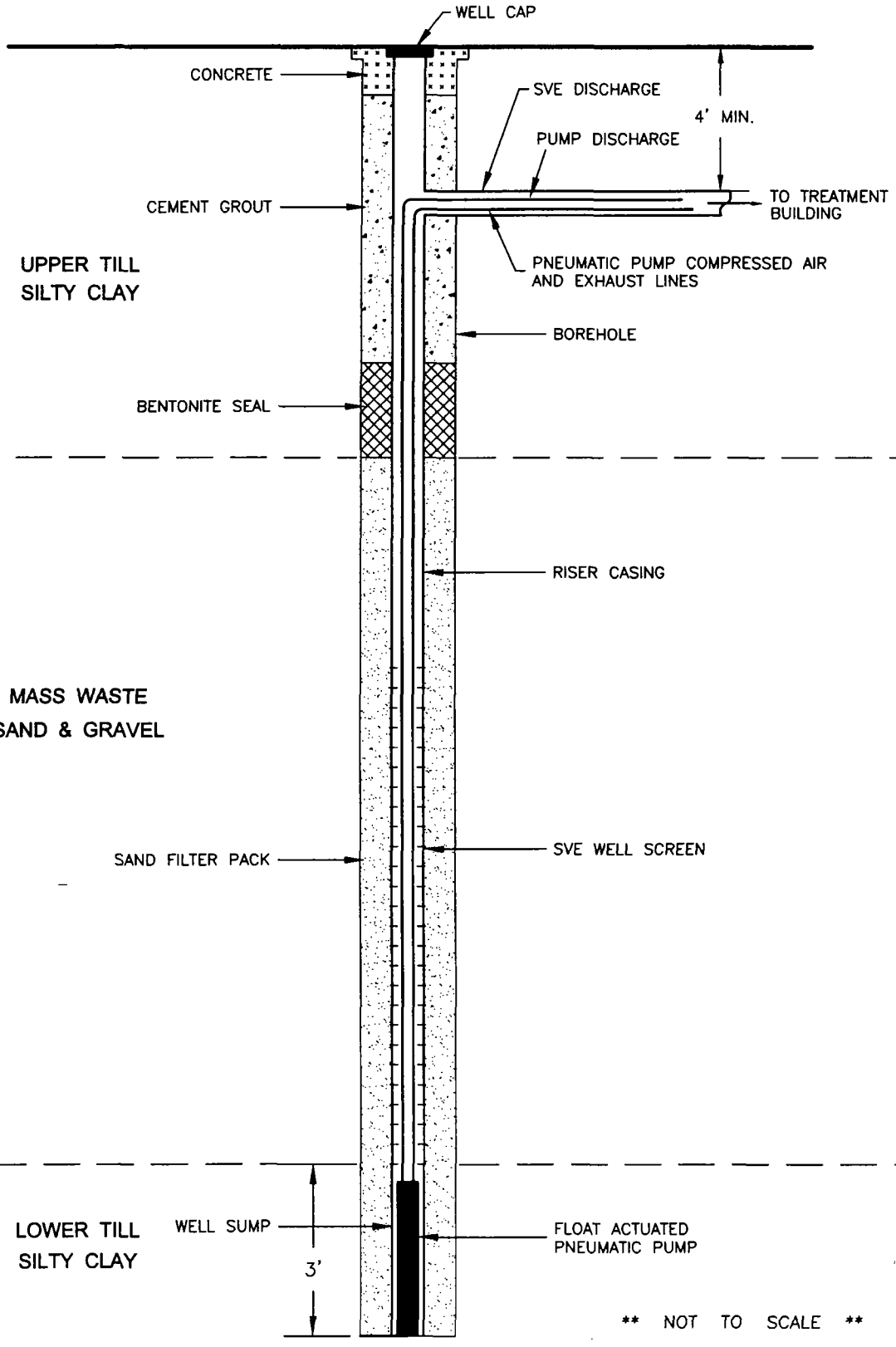
CONCEPTUAL DUAL PHASE EXTRACTION SYSTEM DESIGN
IN MASS WASTE SAND AND GRAVEL

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE 11

GROUNDWATER RECOVERY/VERTICAL EXTRACTION WELL



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DATE	8-24-01
SCALE	NONE
CAD NO.	6526302Y
PRJ NO.	65263.01

TYPICAL DESIGN FOR VERTICAL DUAL PHASE EXTRACTION WELL

LOCKFORMER COMPANY
711 OGDEN AVENUE
LISLE, ILLINOIS

Clayton GROUP SERVICES

FIGURE
12

Figure 13. Sampling locations to assess historic drainageways in the vicinity of the Lockformer Site.

TABLES

TABLE 1
Estimated Concentrations of TCE at Depth within Each Area

The Lockformer Company / Lisle, Illinois

Depth (ft)	CONCENTRATION OF TCE (mg/kg)									
	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10
0-10	0.032	0.01	0.027	58	228	5.8	156	9.4	13	10.6
11-20	86.7	0.025	0.025	89	1420	51.2	206	46.9	42.6	2.4
21-30	0.007	0.003	0.003	0.04	18.7	0.005	0.004	0.005	0.003	0.4

TABLE 2
Estimated Mass of TCE at Depth within Each Area

The Lockformer Company / Lisle, Illinois

Depth (ft)	MASS OF TCE (lbs)										TOTAL	PERCENT
	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10		
0-10	0	0	0	28	202	2	67	3	10	3	315	17
11-20	59	0	0	43	1261	19	89	14	32	1	1517	82
21-30	0	0	0	0	17	0	0	0	0	0	17	1
Totals	59	0	0	71	1480	21	156	17	42	4	1849	
Percent	3	0	0	4	80	1	8	1	2	0		100

ATTACHMENT A

HEALTH AND SAFETY PLAN

Health and Safety Plan

Lockformer
711 Ogden Avenue
Lisle, Illinois

Prepared for:
THE LOCKFORMER COMPANY
Lisle, Illinois

Prepared by:
CLAYTON GROUP SERVICES, INC.
3140 Finley Road
Downers Grove, Illinois 60515
630.795.3200

Clayton Project 15-65263.01

January 2001

Health and Safety Plan

Lockformer
711 Ogden Avenue
Lisle, Illinois

Prepared for:
LOCKFORMER
Lisle, Illinois

Prepared by:
CLAYTON GROUP SERVICES, INC.
3140 Finley Road
Downers Grove, Illinois 60515
630.795.3200

Clayton Project 15-65263.01

January 2001

Ron B. St. John
Site Safety Officer — 1/19/01 Date

Russell J. Chadwick
Health and Safety Officer — 1/19/01 Date

Darren W. Lamsma
Alternate Site Safety Officer — 1/19/01 Date

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CONTENTS
(Continued)

CONTENTS
(Continued)

FIGURES

TABLES

ATTACHMENTS

ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
CHRIS	Chemical Hazards Response Information System
Clayton	Clayton Group Services, Inc.
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
eV	Electron-volt
HASP	Health and Safety Plan
MSDS	Material Safety Data Sheets
NIOSH	National Institute for Occupational Safety and Health
OHSO	Office Health and Safety Officer
OSHA	Occupational Safety and Health Administration
PHSO	Project Health and Safety Officer
PID	Photoionization detector
PM	Project Manager
PPE	Personal protection equipment
PPM	Parts per million
SHSO	Site Health and Safety Officer
USCG	United States Coast Guard

1.0 GENERAL INFORMATION AND SCOPE OF WORK

The Lockformer Company (Lockformer) retained Clayton Group Services, Inc. (Clayton) to conduct site investigation activities at the Lockformer facility located at 711 Ogden Avenue in Lisle, Illinois. Figure 1 shows the location of the subject property.

This Health and Safety Plan (HASP) describes the general procedures that are to be implemented to protect Clayton and its subcontractors involved with field investigation activities to be conducted at the Lockformer property.

1.1 PROJECT DESCRIPTION

The proposed principal field activities to be conducted include:

- Drilling soil borings
- Collecting soil samples from borings
- Installing groundwater monitoring wells
- Developing wells
- Measuring groundwater elevations
- Collecting groundwater samples
- Performing slug tests
- Surveying

1.2 SITE LOCATION, HISTORY, AND CURRENT CONDITIONS

The Lockformer property is located at 711 Ogden Avenue, within the city limits of Lisle, in DuPage County, Illinois. The property is located within the southeast ¼ quarter of the

southeast ¼ quarter of the southwest ¼ quarter of Section 2, Township 38 North, Range 10 East, in Lisle, Illinois.

The eastern portion of the property is developed with a partial two-story office / manufacturing building. The subject building is a rectangular-shaped structure utilized for the manufacture of sheet metal processing equipment and roll forming machines. The subject building contains approximately 88,000 square feet of area and is constructed of masonry and metal truss atop a concrete slab foundation. A partial basement is located under the office portion of the building. A grassy landscaped area is located at the northernmost portion of the property, adjacent to Ogden Avenue. Asphalt parking lots are located at the north and west ends of the building, and an asphalt drive and truck dock is at the northeast portion of the property. A grassy area is at the rear of the building. A water reservoir for back-up sprinkler purposes and an onsite water well used in the manufacturing process are located at the northeast corner of the building. The west portion contains approximately 11.3 acres of undeveloped land and is located immediately west of the parking areas.

The site and surrounding area were developed in approximately 1940; however, based on available information the onsite building was built between 1965 and 1968. Soil was excavated during the reconstruction of Ogden Avenue and used as fill material on the subject property. The excavation and fill activities took place in the 1960s.

According to available information, the subject property was originally owned and developed by Lambertsons Sheet Metal Machinery. Beginning in 1979, Fronimac owned the property for a span of two years, before it was purchased in approximately 1982 by MetCoil Systems Corporation (MetCoil). The Lockformer Company is a subsidiary of MetCoil.

1.3 PROJECT SAFETY REQUIREMENTS

1.3.1 Personnel

Clayton personnel responsible for the health and safety of Clayton employees on this project include:

- Office Health and Safety Officer (OHSO): Russell J. Chadwick
- Site Health and Safety Officer (SHSO): Darren W. Lamsma
- Alternate: To Be Determined
- Project Manager: Ron St. John

The following individuals located onsite will have the authority and responsibility to change levels of protection and, when necessary, shut down the operation:

- Site Health and Safety Officer

PERSONNEL ROLES

Office Health and Safety Officer:

The Office Health and Safety Officer (OHSO) has overall responsibility for establishing appropriate health and safety procedures. The OHSO is responsible for documenting that employees have received proper health and safety training and have participated in a medical surveillance program.

Site Health and Safety Officer:

The Site Health and Safety Officer (SHSO) is responsible for documenting that the designated procedures and health and safety protocol are implemented in the field. The SHSO may be required to perform various types of area or personnel monitoring for purposes of verifying worker exposure and proper selection of personal protective

equipment. The SHSO should be consulted before any changes in the recommended procedures or levels of protective clothing are made.

Project Manager:

The Project Manager (PM) has the primary responsibility for the fulfillment of the terms of the contract. He must oversee operations and ensure that all legal and safety requirements are met. It is his duty to keep the project on schedule and within budget, and to communicate with the client regarding the progress toward the specified project goals.

1.3.2 OSHA-Required Training and Medical Surveillance

Clayton employees and subcontractors who will be on the site will have received a minimum of 40 hours of hazardous waste site investigation health and safety training, and annual 8-hour Refresher Courses, as required in 29 CFR 1910.120, and be a participant in a medical surveillance program.

1.3.3 First Aid

The Clayton SHSO will be immediately advised of any situation requiring more than minor first aid. A first aid kit that meets the requirements of 29 CFR 1926.50 is maintained in each of the Clayton vehicles, and supplies will be replenished by the SHSO as needed. Personnel aware of accidents or injuries will take immediate action to ensure that appropriate first aid is administered and report the incident to the SHSO. The SHSO is trained in first aid/CPR.

1.4 GENERAL GUIDELINES

The following personal hygiene and work conduct guidelines are intended to prevent injuries and adverse health effects. These practices establish general precautionary measures for reducing the risks associated with potentially hazardous work at site operations.

- Eating, drinking, chewing gum or tobacco, taking medications, and smoking are prohibited onsite during field activities.
- Avoid direct contact with potentially contaminated substances; to the extent possible do not walk through puddles, pools, drill cuttings, or mud; avoid kneeling, leaning, or sitting on the drums or working equipment. Do not place monitoring or sampling equipment on potentially contaminated surfaces.
- Be alert to potentially changing exposure conditions, including changes in wind direction, perceptible odors, unusual appearances of soil or groundwater, etc.
- Be alert to fatigue, heat or cold stress, and other environmental factors influencing the normal caution and efficiency of personnel.
- Onsite personnel will establish prearranged hand signals or other means of emergency communication when wearing respiratory equipment (equipment seriously impairs speech communications).
- Always use an appropriate level of personal protective gear. Lesser levels can result in unnecessary exposure; excessive levels of safety equipment can impair efficiency and increase the potential for accidents to occur.

1.5 SITE SAFETY MEETING

Site safety orientation/training meetings (briefings) will be convened (1) before the field team begins work at the site; (2) when there are modifications to the HASP that are applicable to the field personnel; and (3) when additional personnel or subcontractors begin work. Meetings will be attended by personnel involved in carrying out the project and will be presided over by the SHSO or his/her designee.

The meeting agenda will include the following minimum activities:

- Review the HASP with the attendees.
- Distribute any HASP modifications.
- Collect the attendees' signatures acknowledging receipt and understanding of the site and HASP and their agreement to comply with the plan (Tailgate Meeting Minutes Form, Attachment A).

2.0 HAZARD EVALUATION

Available data for the site indicate that potential chemical hazards may be present in various environmental media onsite. The following summarizes the potential chemical and physical hazards associated with each of the planned field activities:

Field Activity	Potential Hazard
Soil Boring and Soil Sampling	Direct contact with contaminants in soil; heat/cold stress; heavy machinery noise; trips, slips, and falls; inhalation or ignition of escaping vapors or gases; inhalation of windblown dust; contact of drill rig with underground lines and of drill rig mast with overhead electrical lines.
Drilling, Installing, and Developing Monitoring Wells	Direct contact with contaminants in soil, groundwater; heat/cold stress; heavy machinery noise; trips, slips, and falls; inhalation or ignition of escaping vapors or gases; inhalation of windblown dust; contact of drill rig with underground lines and of drill rig mast with overhead electrical lines.
Water Level Determination, Slug Testing, and Groundwater Sampling	Direct contact with contaminants in groundwater; heat/cold stress; trips, slips, and falls; inhalation or ignition of escaping vapors or gases in wells.
Surveying	Trips, slips, and falls; inhalation of windblown dust.

2.1 SIGNS AND SYMPTOMS OF ACUTE EXPOSURE

The majority of tasks slated for this project, at this time, involve sampling soil and, potentially, groundwater. These tasks could involve possible exposure to substances that may be hazardous to the health of site personnel. The risk of exposure via inhalation and skin contact is likely greater than ingestion. None of the suspected contaminants onsite

are expected to volatilize in quantities great enough to permit dermal absorption of the gas.

The signs and symptoms that may occur (function of concentration) as a result of exposure to some potentially hazardous constituents at the site are listed below:

- *Trichloroethene:* Symptoms of exposure include irritation of eyes and skin, headache, vertigo, visual disturbance, fatigue, giddiness, tremors, somnolence, nausea, vomiting, dermatitis, cardiac arrhythmias, paresthesia, and liver injury. The target organs include the eyes, skin, respiratory system, heart, liver, and central nervous system.

- *Tetrachloroethene:* Symptoms of exposure include irritation of eyes, nose, and throat, nausea, flush face and neck, vertigo, dizziness, incoordination, headaches, somnolence, skin erythema, and liver damage. The target organs include the eyes, skin, respiratory system, liver, kidneys, and central nervous system.

- *1,2-Dichloroethene:* Symptoms of exposure include irritation of eyes and respiratory system, and central nervous system depression. The target organs include eyes, respiratory system, and central nervous system.

- *Vinyl Chloride:* Symptoms of exposure include weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities, liquid, and frostbite. The target organs are the liver, central nervous system, blood, respiratory system, and lymphatic system.

- *1,1,1-Trichlorethane:* Symptoms of exposure include irritation of eyes and skin, headache, lassitude, central nervous system depression, poor equilibrium, dermatitis, cardiac arrhythmias, and liver damage. The target organs are the eyes, skin, central nervous system, cardiovascular system, and the liver.

- *1,1,2-Trichloroethane:* Symptoms of exposure include irritation of eyes and nose, central nervous system depression, liver and kidney damage, and dermatitis. The target organs are the eyes, respiratory system, central nervous system, liver and kidneys.

The above information is from the *NIOSH Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Services, June 1997.

2.2 COLD STRESS

When temperatures are expected to be in the 40s or lower, especially during high winds, cold stress will be considered. Cold stress presents several different syndromes: mild hypothermia and profound hypothermia, frostbite, and chilblains.

The signs and symptoms of hypothermia include shivering, poor coordination, slowed pace, irritability, slurred speech, fatigue, and poor judgement. More severe hypothermia can result in stupor, collapse, and eventually death.

The signs and symptoms of frostbite include stiffness and numbness in body parts (i.e., nose, ears, toes, fingers, etc.), and a noticeable grayish or whitish skin color.

Workers will be encouraged to wear layers of protective, insulated clothing; keep hands, head, and feet covered and warm; keep clothes dry; eat high energy foods; and drink plenty of water.

Warm shelter will be provided out of the wind for rest periods. Crews will be encouraged to get warm and dry during lunch periods. Warm liquids with caloric value will be provided, and ample water is essential. Dehydration is a factor in hypothermia and frostbite, and will be avoided.

Table 1 describes the recommended breaks for a four-hour work period during periods of cold weather.

The medical emergency response procedures for victims who may have developed cold stress are outlined in Section 5.0.

2.3 HEAT STRESS

When activities may require the use of coveralls and/or respirators, certain precautions will be required to reduce the likelihood of heat fatigue, heat exhaustion, and heat stroke. Heat stroke, in particular, is a life-threatening condition. All employees will be alert to the symptoms of heat exhaustion, which include extreme fatigue, cramps, dizziness, headache, nausea, profuse sweating, and pale clammy skin.

Heat stroke or the stage immediately preceding it includes bright red skin, or a bluish face or conjunctiva, tremors leading to convulsions, delirium, struggling, bright red chest area, hot skin, headache, and vertigo. Collapse, unconsciousness, coma, and death may follow.

Workers will be encouraged to drink liquids from the time they wake up and frequently during the workday. Table 2 describes the recommended minimum breaks for work performed in protective clothing during hot weather.

The medical emergency response procedures for a victim who may have developed heat stress are described in Section 5.0.

2.4 HEAVY MACHINERY

Heavy machinery will be onsite during drilling activities, and particular care will be maintained to avoid accidents. The hazard is increased if personal protective gear that reduces mobility is required. Many opportunities for accidents exist while working near drilling rigs. In general, workers will be aware of the danger of:

- Falling or swinging objects suspended from winches or cables.
- Drilling hardware breaking and flying free, especially while the rig is operating near its limit.

- Contacting overhead electrical lines with the drill rig mast.
- Exploding hoses.
- Entangling personal protective equipment with moving machinery (i.e., spinning augers, etc.).
- Slips, trips, and falls on drilling equipment (e.g., augers, etc.).

Each drilling rig and drilling method presents different specific hazards. Drilling rig and drilling method specific hazards will be discussed in the site safety meeting prior to initiating work and/or if a new method or drilling rig will be used at the site.

The onsite drilling supervisor is responsible for ensuring that the drill rig and the drilling site are ready for safe work conditions. He/she is responsible for ensuring that safe working procedures are followed.

The area utility locator will be contacted prior to drilling to determine the location of all suspected utility lines onsite. The use of a drill rig in the vicinity of electrical power lines, either overhead or buried, requires that special precautionary measures be taken by all involved in site work operations.

2.5 NOISE

Excessive noise is typically encountered while working with heavy machinery such as drilling rigs. The effects of working in the vicinity of noise include:

- Workers being startled, annoyed, or distracted.
- Physical damage to the ear, pain, and temporary and/or permanent hearing loss.

- Communication interference that may increase potential hazards due to the inability to warn of danger and the proper safety precautions to be taken.

Hearing protection will be required for drillers/personnel positioned near drill rigs or when in the immediate vicinity of these types of heavy equipment. Hearing protection will be available onsite (Section 4.4). The effect of occupational exposure to noise is monitored by Clayton or the subcontractor medical surveillance program. Since voice communication may be affected during excessive noise, hand signals may be used in conjunction with voice communication. Hand signals are discussed in Section 4.1.

3.0 SITE MONITORING AND ACTION LEVELS

Air monitoring will be performed in order to ensure that appropriate engineering controls and personal protective equipment are adequate for the tasks being performed. During activities in which atmospheric monitoring is required, a photoionization detector (PID) with a 10.2 electron-volt (eV) lamp will be used. Most potentially hazardous volatile organic compounds are readily detectable with a PID instrument. The PID will be calibrated at the beginning of each day.

3.1 MONITORING FREQUENCY

The following chart summarizes the initial frequency of air monitoring with the PID for each of the principal field activities.

Field Activities	Initial Location and Frequency of Monitoring
Soil boring and soil sampling	Check borehole and breathing zone periodically during drilling/augering for escaping vapors. Monitor during the handling of the sample.
Drilling, installing, and developing groundwater monitoring wells	Check borehole and breathing zone periodically during drilling for escaping vapors.
Water level determination, slug testing and groundwater sampling	Check well and breathing zone initially after opening well.

Air monitoring may be decreased or increased in frequency depending on the conditions identified during field activities.

3.2 ACTION LEVELS

Unless otherwise stated, the following PID action levels are for the breathing zone.

PID Reading (in ppm)	Personal Protection Level
Non-intrusive activity	Level D
Background < PID<5	Level D
5 < PID <50	Level C organic vapor cartridges
50 ≤ PID	Evacuate work area, allow to vent for 10 minutes, and then monitor again. If still above action level, evacuate area and contact SHSO.

NOTES:
The action levels were obtained from the *NIOSH Pocket Guide to Chemical Hazards*, U.S. Department of Health and Human Services, June 1997.
ppm = parts per million

Readings taken in the breathing zone will be documented in a field logbook. Respirators will be donned if Level C action levels are exceeded, and they may be removed once Level C action levels are no longer exceeded. If the action levels for evacuation of the work area are exceeded, work will be suspended in the immediate vicinity of the borehole for 10 minutes in order to allow the excavation to vent. After the 10-minute venting period, air in the breathing zone will be monitored by a Clayton field supervisor wearing a respirator and approaching the hole from the upwind direction. If the PID indicates that organic vapor concentrations are less than the action levels, work will continue; otherwise, the hole will be allowed to continue to vent for 10 additional minutes and the process will be repeated. If air monitoring results in the breathing zone continue to exceed action limits, the work area will be evacuated.

4.0 ONSITE CONTROL

4.1 SITE COMMUNICATION

When voice communication is not possible, field investigators may utilize the following signals:

- Waving hand toward the body in a "come here" gesture - COME HERE.
- Pushing one or both hands away from the body in a "back up" gesture - BACK UP.
- Extending both arms, hands open, palms forward, and stopping them abruptly, directly in front of the torso at shoulder level - STOP RIGHT WHERE YOU ARE.
- Throwing the right clenched fist with extended right thumb abruptly over the right shoulder in a "let's get out of here" gesture – LET'S GET OUT OF HERE!
- Thumbs up - YES/EVERYTHING'S OKAY.
- Thumbs down - NO/THIS DOESN'T LOOK GOOD.
- Hands grasping throat – I'M CHOKING/OUT OF AIR.
- Hands of top of head - I NEED ASSISTANCE.

4.2 SAFETY ZONES AND ACCESS CONTROL

Control boundaries for site work will be established and will consist of the Exclusion Zone, the Decontamination Zone, and the Clean Zone. The following is a description of each control zone:

- The Exclusion Zone will be the area within 10 feet around an onsite monitoring well, borehole, or sampling point.

- The Decontamination Zone (contamination reduction where decontamination takes place) will be the area from the perimeter of the Exclusion Zone to a 15- to 20-foot radius.
- The Clean Zone (support area where workers should not be exposed to hazardous conditions) will be the area beyond the Decontamination Zone.

Movement of equipment and personnel among these zones should be minimized to prevent cross-contamination from contaminated areas to clean zones.

Site personnel will be briefed by the SHSO as to the location of work areas and Exclusion Zones, decontamination area, telephone(s), eye wash, fire extinguisher(s), prevailing wind direction, utility lines (if not marked onsite), and first aid kit(s).

Potable water for health and safety procedures and decontamination procedures will be brought to the site as needed by site personnel and will be available in the Decontamination Zone and in the Clean Zone.

4.3 PERSONAL PROTECTIVE EQUIPMENT

All site investigatory activities will begin and will likely be completed using Level D personal protection equipment (PPE). The PPE will be upgraded to Level C if breathing zone atmosphere exceeds Level C action levels. In instances of continued windblown dust, Level C 1 HEPA filters shall be used. The specific PPE required for Level C and D is outlined in Table 2. Hearing protection will be available and is recommended to be used during drilling operations.

Where air purifying respirators are deemed necessary, organic vapor cartridges appropriate for use with the substances and concentrations anticipated will be worn (Level C). The make of the respirator and cartridge varies for each person depending on the results of individual fit-tests. Cartridges will be replaced at the start of each work day

and if or when breakthrough occurs. Changes to the levels of protection will not be made without the knowledge and approval of the SHSO.

A respiratory protection plan is in effect at Clayton. Clayton field personnel have been properly trained in care and maintenance of respirators. Clayton field personnel have been properly fitted and fit-tested according to OSHA regulations. Clayton personnel have been medically evaluated and cleared for respiratory protection use by a licensed physician.

4.4 ADDITIONAL EMERGENCY AND SAFETY EQUIPMENT

Whenever work is conducted, the following equipment will be available at the job site (e.g., Clayton field vehicle, or at a designated location in the Clean Zone):

- Ear plugs, disposable
- An ABC fire extinguisher (inspected annually)
- First aid kit that meets the requirements of 1926.50
- Traffic cones, and/or caution tape

In addition, Material Safety Data Sheets (MSDS) or Chemical Hazards Response Information System (CHRIS) Sheets will be available at the site for substances that pose a reasonable health and safety risk to site personnel as listed in Section 2.1. MSDS and CHRIS Sheets are included as Attachment B.

4.5 DECONTAMINATION

All work will be performed in Level D personal protection, and no personal decontamination area will be set up. Should conditions change at the site causing an upgraded level of protection, an area will be specified and all workers informed of the necessary procedures.

All nondisposable sampling equipment that comes into contact with site soils, sediments, and surface water will either be steam cleaned or washed with a detergent solution and rinsed with distilled water.

While in Level D, all disposable protective clothing will be disposed of as general refuse. Decontamination of equipment will take place on designated areas onsite. If an upgrade to Level C occurs, all nondisposable protective equipment will be cleaned in a specified contaminant reduction zone prior to leaving the site. The protective equipment will be cleaned with a detergent wash and rinsed with distilled water. Rinsate water will be managed and remain onsite.

5.0 CONTINGENCY AND EMERGENCY PROCEDURES

The nearest telephone will be a Clayton mobile phone. Subcontractors may also have a mobile phone.

The following contingency plans have been developed to deal with major incidents that might occur during field activities. Clayton employees and subcontractors will familiarize themselves with the location of the nearest permanent phone and the designated medical facility. The location of Advocate Good Samaritan Hospital is shown on Figure 2, together with the shortest route from the site to the hospital. The route is as follows:

1. Go east on Ogden Avenue to Main Street.
2. Take Main Street (becomes Highland Ave.) north to Advocate Good Samaritan Hospital.

A copy of the "List of Emergency Telephone Numbers" (Section 5.6) will be carried along with Clayton's and the subcontractors' (if available) mobile phones. Contingency response plans will be reviewed with onsite personnel weekly to promote timely implementation of the contingency plan should one of the events described in the following section occur.

5.1 MEDICAL EMERGENCY RESPONSE PLAN

Should any person visiting or working at the site be injured or become ill, notify the SHSO and initiate the following emergency response plan:

Note: *The anticipated nature of chemical contamination on this project does not present an immediate threat to human health. Other than removal of outer garments and*

gross contamination, immediate emergency treatment of injuries will take precedence over rigorous personal decontamination.

1. If able, the injured person will proceed to the nearest available source of first aid. If necessary, wash the injured area with soap and water.

2. If the injury involves foreign material in the eyes, immediately flush the eyes with emergency eye wash solution, and rinse with copious amounts of water at the nearest emergency eye wash station. Obtain or administer first aid as required. If further medical treatment is required, seek medical assistance as discussed below.

3. If the victim is unable to walk, but is conscious, and there is no evidence of spinal injury, escort or transport the injured person to the nearest first aid facility. If the victim cannot be moved without causing further injury, such as in the case of a severe compound fracture, take necessary emergency steps to control bleeding and immediately call for medical assistance as discussed below.

    - If the victim is unconscious or unable to move, **Do Not Move the Injured Person Unless Absolutely Necessary to Save His or Her Life**, until the nature of the injury has been determined.

    - If there is any evidence of spinal injury, do not move the victim. Administer CPR if the victim is not breathing, control severe bleeding, and immediately contact the Advocate Good Samaritan Hospital Emergency Room at 630.275.5900 and advise them of the situation. Otherwise, seek medical assistance as discussed below.

4. If the injury to the worker is related to the physical hazards previously identified in Section 2.0, appropriate first-aid procedures will be instituted as follows:

    - *Hypothermia* - If a worker suffers from hypothermia, medical attention will be sought immediately. The employee will be moved out of the cold, and warm clothing or blankets will be provided. Warming will take place slowly; no food or beverage will be administered.

    - *Frostbite* - Any worker suffering from frostbite will be moved to a warm area immediately. Frostbitten areas of the body will be placed in warm (100 to 105 degrees) water, NOT hot water. Areas of concern will be handled gently and will not be rubbed or massaged. If toes or fingers are affected, gauze will be placed between them after warming them. The injured parts will be loosely bandaged. If the part has been thawed and refrozen, it will be re-warmed at room temperature. If necessary, medical assistance will be sought.

- *Heat Stroke* - If a worker suffers a heat stroke, medical attention will be sought immediately. The victim will be moved out of the heat and into a cooler area. The victim will be cooled as quickly as possible by immersing him or her in a cool bath, or wrapping wet sheets around the body. While waiting for an ambulance to arrive, the victim will be watched for symptoms of shock. Nothing will be given orally.

- *Heat Exhaustion* - If any worker suffers from heat exhaustion, he or she will be moved out of the heat and into a cooler place. The victim will lie down with his or her feet up. Clothing will be removed or loosened; cold packs, wet towels, or sheets will be used to cool the skin. One-half glass of water will be administered every 15 minutes if the victim is fully conscious and can tolerate it. During all of these procedures, the victim will be observed for symptoms of shock. If the victim has not recovered within a half hour, or if the victim's condition worsens, medical attention will be sought.

5. If further medical treatment is required and

   (a) The injury is not severe, contact Advocate Good Samaritan Hospital and take the injured party to the hospital by private automobile.

   (b) The injury is severe, immediately call EMS (911). In the interim, call the Advocate Good Samaritan Hospital Emergency Room (630.275.5900) and advise them of the situation.

6. The SHSO will accompany the injured person to the hospital to ensure prompt and proper medical attention. After proper medical treatment has been obtained, the SHSO will notify the OHSO and prepare a written report.

5.2 FIRE AND EXPLOSIONS

In the event of a fire or explosion the SHSO will take the following steps:

1. If the situation is readily controllable, take immediate action to do so.

2. If the situation is uncontrollable, clear personnel working in the immediate area and notify the local Fire Department (911).

3. Notify the OHSO.

Clayton personnel will remain at the scene of the fire until the local fire department arrives. Once professional fire fighting personnel have arrived, Clayton personnel will remain at the disposal of the fire chief. The SHSO will function as liaison between response personnel in the incident.

5.3 CHEMICAL EXPOSURE FIRST AID

The following procedures will be followed in case of chemical exposure during field activities:

- *Eye contact*: Flush with clean water for 15 minutes or more. Try to flush under the lids. Get medical attention immediately.
- *Inhalation*: Get person to fresh air. Monitor for signs of exposure. Watch for signs of respiratory difficulty. Call EMS. Perform emergency rescue breathing, if appropriate, until relieved by an emergency unit.
- *Skin contact*: Flush area with clean water for at least 15 minutes. If burns are evident, get immediate medical attention. Do not use soap on affected area. BEWARE: Signs and symptoms may develop later due to dermal exposure.
- *Ingestion:* If contaminated materials are ingested, vomiting will not be induced. Medical attention will be sought immediately.

If anyone has been overexposed or has shown or is showing signs of exposure, he/she will be examined by a physician, according to OSHA's 1910.120 (f).

5.4 UNFORESEEN CIRCUMSTANCES

The Health and Safety procedures specified in this plan are based on available data that suggest minimal potential for worker exposure to significant levels of hazardous substances. If substantially higher levels of contamination are encountered in the soil or groundwater, and/or if situations arise that are obviously beyond the scope of the monitoring, respiratory protection, and decontamination procedures specified, work activities will be modified or, if necessary, halted pending discussion with the OHSO and implementation of appropriate protective measures.

5.5 LIST OF EMERGENCY TELEPHONE NUMBERS

Medical Services (EMS)	911
Police/ Fire Department	911 -- Emergency
Advocate Good Samaritan Hospital 3815 Highland Avenue Downers Grove, Illinois	630.275.5900
Poison Control Center	800.942.5969
National Response Center	800.424.8802
Clayton Group Services, Inc. (Mr. Ron St. John or Mr. Russell J. Chadwick)	630.795.3200
Lockformer Mr. Rian Scheel	630.964.8000

6.0 CONFINED SPACE ENTRY

Site personnel will not be entering any confined spaces during field activities; therefore, confined space entry procedures are not required.

7.0 SPILL CONTAINMENT PROGRAM

Spills requiring a written spill containment program are not anticipated for the proposed activities. Groundwater generated during development or purging of monitoring wells will be collected and staged in a secure area onsite in 55-gallon drums. All drums will be labeled as to their contents and date of origin. Upon receipt of analytical data, the water will be characterized, if necessary. The drummed waters will then be appropriately managed offsite. In the event the water does not require offsite disposal, it will be spread on the site.

8.0 REFERENCES

American Conference of Governmental Industrial Hygienists (ACGIH). *1991-1992 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices,* 1991.

Clayton Environmental Consultants. *Corporate Safety and Health Plan,* 1997.

40 CFR 300 National Contingency Plan.

National Institute for Occupational Safety and Health (NIOSH) / OSHA / United States Coast Guard (USCG) / Environmental Protection Agency (EPA). *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities,* October 1985.

Occupational Safety and Health Administration (OSHA). Construction Industry Standards 29 CFR 1926.

OSHA General Industry Standards 29 CFR 1910.120. *Hazardous Waste Operations and Emergency Response.*

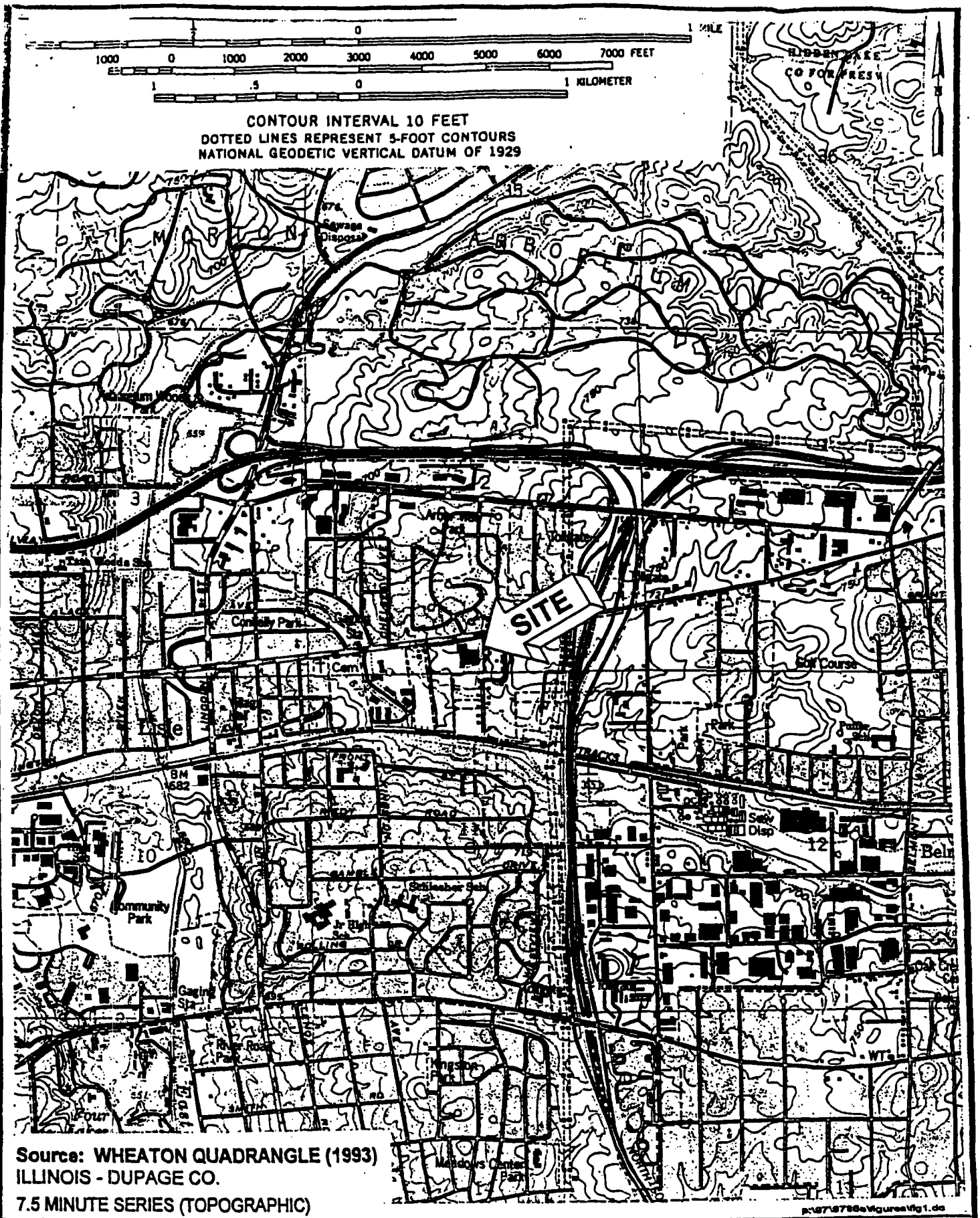
U.S. Department of Health and Human Services. *NIOSH Occupational Health Guidelines for Chemical Hazards,* January 1991.

U.S. Department of Health and Human Services. *NIOSH Pocket Guide to Chemical Hazards,* June 1997.

ISOPIA Guidance Document. *Standard Operating Safety Guides,* June 1992.

ISOPIA software. *Superfund Health and Safety Planner,* 1993.

FIGURES



Source: WHEATON QUADRANGLE (1993)
ILLINOIS - DUPAGE CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

P:\87\8786a\figures\fig1.ds

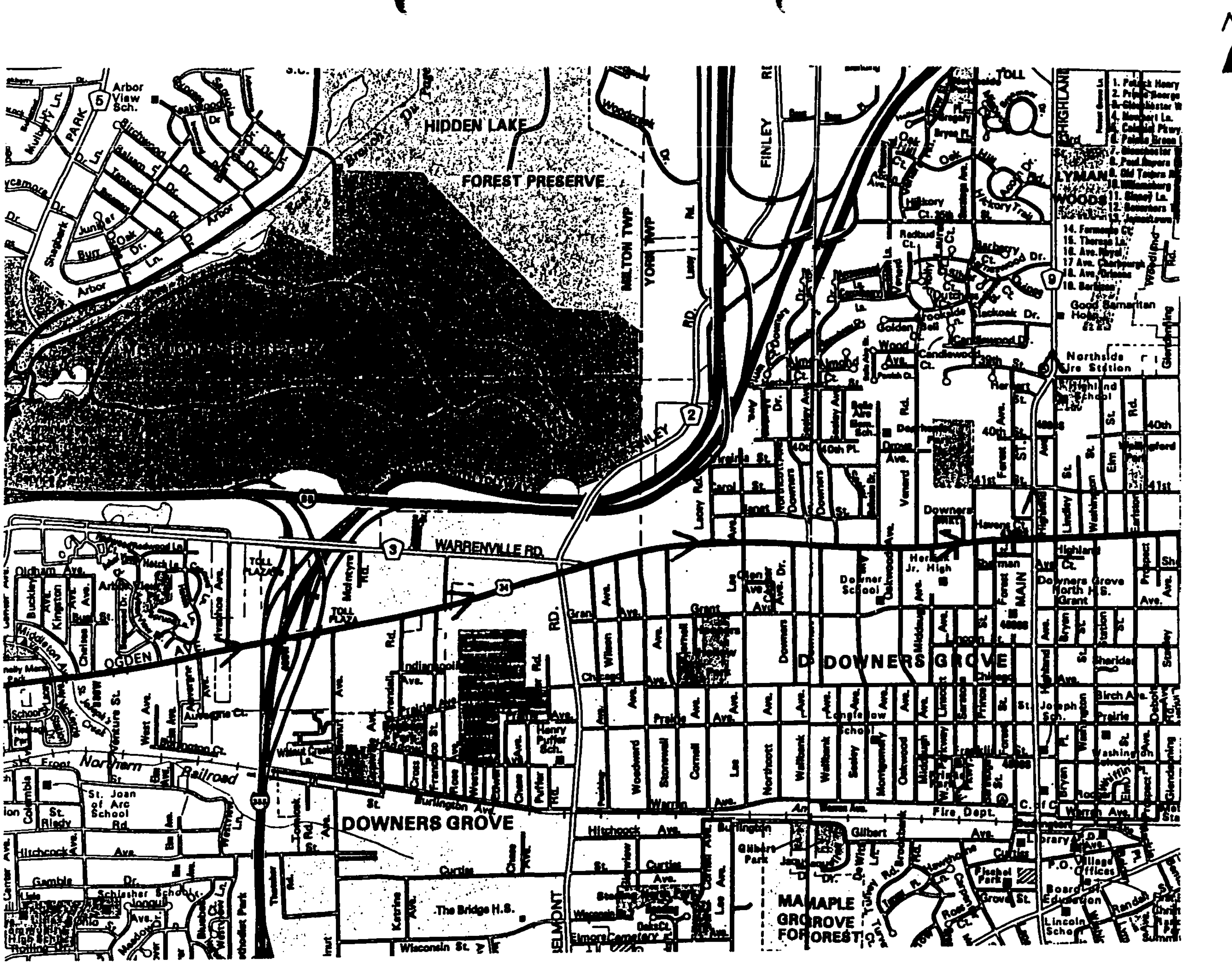
CARLSON ENVIRONMENTAL, INC.
65 E. Wacker Place
Chicago, Illinois
(312) 346-2140

SCALE 1 : 24,000

TOPOGRAPHIC SITE LOCATION MAP

711 OGDEN AVENUE
LISLE, ILLINOIS

DRAWN: LPM	CHKD:	SCALE: 1 : 24,000	FIGURE: 1
DATE: 12/07/88		PNR: 8786A	


N
HIDDEN LAKE
FOREST PRESERVE
WARRENVILLE RD.
OGDEN AVE.
DOWNERS GROVE
FINLEY RD.
MILTON TWP
YORK TWP
LYMAN WOODS
Good Samaritan Hosp.
Northside Fire Station
Highland School
Downers Grove North H.S.
Herrick Jr. High
Downer School
Henry Puffer Sch.
St. Joan of Arc School
The Bridge H.S.
Northern Railroad
Burlington Ave.
Warren Ave.
Fire Dept.
Library
P.O. Village Offices
Board of Education
Lincoln School
Gilbert Park
Fishel Park
MAPLE GROVE FOREST
BELMONT
TOLL PLAZA

1" = 0.45 mi

TABLES

TABLE 1

Properties of Potentially Hazardous Substances of Concern*

Chemical	IDLH (ppm)	REL (ppm)	PEL (ppm)	Skin Irritant	Eye Irritant	Respiratory Irritant	Flash Point (F)	LEL (%)	UEL (%)	Vapor Pressure (mm Hg)	Ionization Potential (eV)
Benzene	3,000	0.1	1	Yes	yes	yes	12	1.3	7.9	75	9.24
Toluene	2,000	100	100	Yes	no	no	40	1.2	7.1	20	8.82
Xylenes	1,000	100	100	Yes	yes	yes	63-81	1.0-1.1	7.0	7-9	8.44-8.56
Tetrachloroethene	500	lowest feasible	25	Yes	yes	yes	none	none	none	14	9.32
Trichloroethene	1,000	25	50	Yes	yes	yes	90	8	10.5	58	9.45
1,2-dichloroethene cis-1,2-dichloroethene trans-1,2-dichloroethene	4,000	200	200	Yes	yes	yes	36	5.6	12.8	180-264	9.65
Vinyl chloride	carcinogen	lowest feasible	1	Yes	yes	yes	none	3.6	33	>1 atm	9.99

* NIOSH Occupational Health Guidelines for Chemical Hazards, U.S. Department of Health and Human Services, January 1991.

NOTES: 1. IDLH = Quantity that is rapidly fatal or likely to promote life-threatening disease.
2. REL = NIOSH's Recommended Exposure Limit
3. PEL = OSHA's Permissible Exposure Limit

TABLE 2

Recommended Minimum Breaks for Work Performed in Protective Clothing during Hot Weather

Temp. (°F)	Work	Rest	Comments
70 to 75	3 hours	5 mins	Review heat stress in a safety meeting. Schedule a beverage break every 2 hours at a minimum.
75 to 80	3 hours	15 mins	Seated rest. Drink at least 8 ounces at each break. Monitor daily body weight changes. Have at least 10 instant ice packs or bags of ice available.
80 to 85	2 hours	10 mins	As above, but rest area to be shaded. Take pulse before work, at beginning of lunch break, and at end of day.
85 to 90	90 mins	10 mins	As above, and try to provide a shaded work area. More frequent breaks may be required.
above 90°F	90 mins	10 mins	As above. Try to reschedule work to avoid mid-day heat.

* 1991-1992 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, ACGIH, 1991.

TABLE 3

Levels Of Personal Protective Equipment

LEVEL D	Hard hat Safety glasses or goggles Steel toe boots Latex gloves (task dependent) Work gloves (task dependent) Neoprene gloves (task dependent) Hearing protection Coveralls
LEVEL C	Hard hat Safety glasses or goggles Steel toe boots/impermeable Latex inner gloves Neoprene outer gloves Hearing protection Coveralls Air purifying respirator Cartridges (organic vapor/acid gas)

ATTACHMENT A

TAILGATE MEETING MINUTES FORM

Clayton
ENVIRONMENTAL
CONSULTANTS

TAILGATE MEETING MINUTES

Project No.:_____ Client:_____

Location:_____ Month:_____

# of Employees:_____

Safety Topic #:_____ Title:_____

Other items discussed/listed:

_____

_____

Employee Safety Suggestions:

_____

_____

_____ / _____ _____

Supervisor's signature / Print Name Date

EMPLOYEE NAMES:

Print Name	Signature

COMPLETED FORM TO BE RETURNED TO H&S COORDINATOR

ADMIN\H&S\TGMIN.BDP(031798)

ATTACHMENT B

MSDS AND CHRIS SHEETS

TRICHLOROETHANE

TCE

CAUTIONARY RESPONSE INFORMATION

Common Synonyms			
Aerothene Chlorothene Methylchloroform 1,1,1-Trichloroethane	Watery liquid	Colorless	Sweet odor
	Sinks in water. Irritating vapor is produced.		

Keep people away.
Avoid contact with liquid and vapor
Call fire department
Notify local health and pollution control agencies.
Protect water intakes

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, or foam.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, may produce nausea.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Pump
Do not burn

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 36; Halogenated hydrocarbon
2.2 Formula: CH_3CCl_3
2.3 IMO/UN Designation: Not listed
2.4 DOT ID No.: 2831
2.5 CAS Registry No.: 71-55-6
2.6 NAERG Guide No.: 160
2.7 Standard Industrial Trade Classification: 51134

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or polyvinyl-alcohol-type gloves; chemical safety goggles and face shield; neoprene safety shoes (or leather safety shoes plus neoprene footwear); neoprene or polyvinyl alcohol suit or apron for splash protection.
3.2 Symptoms Following Exposure: INHALATION: symptoms range from loss of equilibrium and incoordination to loss of consciousness; high concentration can be fatal due to simple asphyxiation combined with loss of consciousness. INGESTION: produces effects similar to inhalation and may cause some feeling of nausea. EYES: slightly irritating and lachrymatory. SKIN: defatting action may cause dermatitis.
3.3 Treatment of Exposure: Get medical attention for all eye exposures and any other serious overexposures. Do NOT administer adrenalin or epinephrine; otherwise, treatment is symptomatic. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting. EYES: flush thoroughly with water. SKIN: remove contaminated clothing and wash exposed area thoroughly with soap and warm water.
3.4 TLV-TWA: 350 ppm
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: 450 ppm
3.7 Toxicity by Ingestion: Grade 1; LD_{50} = 5 to 15 g/kg (rat, mouse, rabbit, guinea pig)
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Currently not available
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
3.12 Odor Threshold: 100 ppm
3.13 IDLH Value: 700 ppm
3.14 OSHA PEL-TWA: 350 ppm
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: Currently not available
4.2 Flammable Limits in Air: 7%-16%
4.3 Fire Extinguishing Agents: Dry chemical, foam, or carbon dioxide
4.4 Fire Extinguishing Agents Not to Be Used: Not pertinent
4.5 Special Hazards of Combustion Products: Toxic and irritating gases are generated in fires.
4.6 Behavior in Fire: Not pertinent
4.7 Auto Ignition Temperature: 932°F
4.8 Electrical Hazards: Not pertinent
4.9 Burning Rate: (est.) 2.9 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: 9.5 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 5.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): N_2 diluent: 14.0%

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: Reacts slowly, releasing corrosive hydrochloric acid.
5.2 Reactivity with Common Materials: Corrodes aluminum, but reaction is not hazardous.
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: 75-150 ppm*/pinfish/TL_m/salt water
*Time period not specified.
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): Currently not available
6.4 Food Chain Concentration Potential: None
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 2
Human Oral hazard: 1
Human Contact hazard: 0
Reduction of amenities: 0

7. SHIPPING INFORMATION

7.1 Grades of Purity: Uninhibited; inhibited; industrial inhibited; white room; cold cleaning
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Pressure-vacuum
7.5 IMO Pollution Category: C
7.6 Ship Type: 3
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Keep Away From Food
8.2 49 CFR Class: 6.1
8.3 49 CFR Package Group: III
8.4 Marine Pollutant: Yes
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	1
Instability (Yellow)	0

8.6 EPA Reportable Quantity: 1000 pounds
8.7 EPA Pollution Category: C
8.8 RCRA Waste Number: U226
8.9 EPA FWPCA List: Not listed

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 133.41
9.3 Boiling Point at 1 atm: 165°F = 74°C = 347°K
9.4 Freezing Point: <-38°F = <-38°C = <234°K
9.5 Critical Temperature: Not pertinent
9.6 Critical Pressure: Not pertinent
9.7 Specific Gravity: 1.31 at 20°C (liquid)
9.8 Liquid Surface Tension: 25.4 dynes/cm = 0.0254 N/m at 20°C
9.9 Liquid Water Interfacial Tension: (est.) 45 dynes/cm = 0.045 N/m at 20°C
9.10 Vapor (Gas) Specific Gravity: 4.6
9.11 Ratio of Specific Heats of Vapor (Gas): 1.104
9.12 Latent Heat of Vaporization: 100 Btu/lb = 58 cal/g = 2.4 X 10^5 J/kg
9.13 Heat of Combustion: (est.) 4700 Btu/lb = 2600 cal/g = 110 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: Currently not available
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: 4.0 psia

NOTES

TRICHLOROETHANE

TCE

9.20 SATURATED LIQUID DENSITY		9.21 LIQUID HEAT CAPACITY		9.22 LIQUID THERMAL CONDUCTIVITY		9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit inch per hour-square foot-F	Temperature (degrees F)	Centipoise
0	85.410	55	0.240		N	15	1.363
10	84.870	60	0.242		O	20	1.295
20	84.300	65	0.244		T	25	1.231
30	83.750	70	0.246			30	1.172
40	83.200	75	0.248		P	35	1.117
50	82.650	80	0.250		E	40	1.065
60	82.060	85	0.252		R	45	1.017
70	81.540	90	0.254		T	50	0.972
80	80.981	95	0.256		I	55	0.929
90	80.429	100	0.258		N	60	0.889
100	79.870	105	0.260		E	65	0.852
110	79.320	110	0.262		N	70	0.817
120	78.790	115	0.264		T	75	0.784
130	78.260	120	0.266			80	0.753
140	77.650	125	0.268			85	0.723
150	77.060	130	0.270				
160	76.540	135	0.272				
		140	0.274				

9.24 SOLUBILITY IN WATER		9.25 SATURATED VAPOR PRESSURE		9.26 SATURATED VAPOR DENSITY		9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
80	0.070	70	2.000	70	0.04625	0	0.146
		75	2.364	75	0.05495	25	0.150
		80	2.657	80	0.06119	50	0.155
		85	2.900	85	0.06799	75	0.159
		90	3.335	90	0.07548	100	0.163
		95	3.725	95	0.08346	125	0.167
		100	4.152	100	0.09229	150	0.171
		105	4.619	105	0.10179	175	0.175
		110	5.130	110	0.11196	200	0.179
		115	5.686	115	0.12300	225	0.183
		120	6.292	120	0.13490	250	0.186
		125	6.950	125	0.14770	275	0.190
		130	7.663	130	0.16139	300	0.193
		135	8.437	135	0.17630	325	0.196
		140	9.273	140	0.19220	350	0.199
		145	10.180	145	0.20920	375	0.202
		150	11.150	150	0.22730	400	0.205
		155	12.200	155	0.24670	425	0.208
		160	13.330	160	0.26730	450	0.210
		165	14.540	165	0.28930	475	0.213
		170	15.840	170	0.31270	500	0.215
		175	17.240	175	0.33760	525	0.217
		180	18.730	180	0.36390	550	0.219
		185	20.330	185	0.39180	575	0.222
		190	22.030	190	0.42140	600	0.223

1,1,2-TRICHLOROETHANE

TCM

CAUTIONARY RESPONSE INFORMATION

Common Synonyms			
Ethane, 1,1,2-trichloro- beta-trichloroethane Vinyl trichloride	Liquid	Colorless	Sweet, chloroform like odor
	Sinks in water.		

KEEP PEOPLE AWAY. AVOID CONTACT WITH LIQUID AND VAPOR.
Wear self-contained positive pressure breathing apparatus and full protective clothing.
Shut off ignition sources and call fire department.
Evacuate area in case of large discharge.
Stay upwind and use water spray to "knock down" vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

POISONOUS GASES ARE PRODUCED IN FIRE.
Container may explode in fire.
Wear self-contained positive pressure breathing apparatus, impervious clothing and gloves.
Extinguish fires with water spray, fog or foam, carbon dioxide, or dry chemical.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose, throat, lungs and skin; may cause defatting dermatitis.
Highly toxic; death may result from respiratory failure.
If inhaled, anesthetic or narcotic effect may occur.
Move to fresh air.
If breathing has stoped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes; severe irritant to gastrointestinal tract. Highly toxic.
If swallowed, may cause liver or kidney damage and may increase myocardial irritability.
May cause chemical pneumonia if aspirated into lungs.
IF IN EYES OR ON SKIN, hold eyelids open and flush with water for at least 15 minutes; hold eyelids open if necessary.
Remove and isolate contaminated clothing and shoes at the site.
IF SWALLOWED, and victim is CONSCIOUS, have victim drink water and induce vomiting.
IF SWALLOWED AND VICTIM UNCONSCIOUS OR HAVING CONVULSIONS, just keep victim warm.

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Pump; Dredge

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: 36; Halogenated hydrocarbon
2.2 Formula: $CHCl_2CH_2Cl$
2.3 IMO/UN Designation: Currently not available
2.4 DOT ID No.: Not listed
2.5 CAS Registry No.: 79-00-5
2.6 NAERG Guide No.: Not listed.
2.7 Standard Industrial Trade Classification: 51134

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Self-contained positive pressure breathing apparatus and full protective clothing.
3.2 Symptoms Following Exposure: Inhalation causes irritation of the nose, throat, and lungs. High concentrations may cause death by respiratory failure. Highly toxic by ingestion; may cause liver or kidney damage or myocardial irritability. Causes severe irritation of the gastrointestinal tract. Vapor may produce superficial skin burns or defatting type dermatitis and may irritate the eyes.
3.3 Treatment of Exposure: INHALATION: Move to fresh air; call emergency medical care. If breathing stops, give artificial respiration. If breathing is difficult, give oxygen. INGESTION: If victim is conscious get victim to induce vomiting by touching the back of the throat with his finger or by taking syrup of Ipecac. If victim is unconscious or having convulsions, do nothing except keep victim warm. EYES OR SKIN: Flush with running water for at least 15 minutes; hold eyelids open if necessary. Clean skin with soap or mild detergent. Remove and isolate contaminated clothing and shoes at the site.
3.4 TLV-TWA: 10 ppm (skin)
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 2; LD_{50} = 580 mg/kg (rat)
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Causes liver and kidney damage; may increase myocardial irritability. It is a central nervous system depressant. It is carcinogenic. May cause chemical pneumonia if aspirated into the lungs.
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause moderate irritation such that personnel will not tolerate moderate or high concentrations.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on skin and allowed to remain, may cause smarting and reddening of the skin.
3.12 Odor Threshold: Currently not available
3.13 IDLH Value: 100 ppm (skin)
3.14 OSHA PEL-TWA: 10 ppm (skin)
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: None.
4.2 Flammable Limits in Air: 6.4% - 13.3%
4.3 Fire Extinguishing Agents: Small fires: dry chemical or CO_2. Large fires: water spray, fog or foam.
4.4 Fire Extinguishing Agents Not to Be Used: Not pertinent
4.5 Special Hazards of Combustion Products: Toxic gases including hydrogen chloride and very small amounts of phosgene and chlorine are produced.
4.6 Behavior in Fire: Forms a flammable vapor-air mixture at 108°F and higher.
4.7 Auto Ignition Temperature: Not pertinent
4.8 Electrical Hazards: Currently not available
4.9 Burning Rate: Currently not available
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichometric Air to Fuel Ratio: 9.5 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 5.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: Incompatible with oxidizing material or aluminum. Will attack some forms of plastics, rubber and coatings.
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: 18 mg/l/48 hr/daphnia magna/LC_{50}/fresh water.
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): Currently not available
6.4 Food Chain Concentration Potential: Currently not available
6.5 GESAMP Hazard Profile: Bioaccumulation: 0
Damage to living resources: 2
Human Oral hazard: 1
Human Contact hazard: 0
Reduction of amenities: 0

7. SHIPPING INFORMATION

7.1 Grades of Purity: Technical grade; stabilized; 95%
7.2 Storage Temperature: Currently not available
7.3 Inert Atmosphere: Currently not available
7.4 Venting: Currently not available
7.5 IMO Pollution Category: C
7.6 Ship Type: 3
7.7 Barge Hull Type: 3

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Not listed
8.2 49 CFR Class: Not pertinent
8.3 49 CFR Package Group: Not listed.
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	3
Flammability (Red)	1
Instability (Yellow)	0

8.6 EPA Reportable Quantity: 100 pounds
8.7 EPA Pollution Category: B
8.8 RCRA Waste Number: U227
8.9 EPA FWPCA List: Not listed

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 133.41
9.3 Boiling Point at 1 atm: 236.6°F = 113.7°C = 386.9°K
9.4 Freezing Point: -31/-34.1°F = -35/-36.7°C = 238.2/236.5°K
9.5 Critical Temperature: Currently not available
9.6 Critical Pressure: Currently not available
9.7 Specific Gravity: 1.44 at 20°C (liquid)
9.8 Liquid Surface Tension: 33.75 dynes/cm = 0.0338 N/m at 20°C
9.9 Liquid Water Interfacial Tension: Currently not available
9.10 Vapor (Gas) Specific Gravity: 4.6
9.11 Ratio of Specific Heats of Vapor (Gas): Currently not available
9.12 Latent Heat of Vaporization: Currently not available
9.13 Heat of Combustion: Currently not available
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: Currently not available
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: Currently not available

NOTES

1,1,2-TRICHLOROETHANE

TCM

9.20 SATURATED LIQUID DENSITY		9.21 LIQUID HEAT CAPACITY		9.22 LIQUID THERMAL CONDUCTIVITY		9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit inch per hour-square feet-F	Temperature (degrees F)	Centipoise
68	89.960		CURRENTLY NOT AVAILABLE		CURRENTLY NOT AVAILABLE		CURRENTLY NOT AVAILABLE

9.24 SOLUBILITY IN WATER		9.25 SATURATED VAPOR PRESSURE		9.26 SATURATED VAPOR DENSITY		9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
	INSOLUBLE	0	0.048	0	0.00130		CURRENTLY NOT AVAILABLE
		25	0.093	25	0.00239		
		50	0.178	50	0.00439		
		75	0.344	75	0.00886		
		100	0.650	100	0.01478		
		125	1.265	125	0.02712		
		150	2.427	150	0.04876		
		175	4.658	175	0.09136		
		200	8.933	200	0.16753		

TETRACHLOROETHYLENE

TTE

CAUTIONARY RESPONSE INFORMATION

Common Synonyms	Watery liquid	Colorless	Sweet odor
Perchloroethylene Perclene Perk Tetracap	Sinks in water. Irritating vapor is produced.		

Avoid contact with liquid and vapor
Notify local health and pollution control agencies.
Protect water intakes.

Fire

Not flammable.
Poisonous gases are produced when heated.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Contain
Collection Systems: Pump
Clean shore line

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: Not listed.
2.2 Formula: $Cl_2C{=}CCl_2$
2.3 IMDG/IM Designation: 9.0/1897
2.4 DOT ID No.: 1897
2.5 CAS Registry No.: 127-18-4
2.6 NAERG Guide No.: 160
2.7 Standard Industrial Trade Classification: 51133

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: For high vapor concentrations use approved canister or air-supplied mask; chemical goggles or face shield; plastic gloves.
3.2 Symptoms Following Exposure: Vapor can affect central nervous system and cause anesthesia. Liquid may irritate skin after prolonged contact. May irritate eyes but causes no injury.
3.3 Treatment of Exposure: INHALATION: If illness occurs, remove patient to fresh air, keep him warm and quiet, and get medical attention. INGESTION: Induce vomiting only on physician's recommendation. EYES AND SKIN: flush with plenty of water and get medical attention if irritation or injury occurs.
3.4 TLV-TWA: 25 ppm
3.5 TLV-STEL: 100 ppm
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 2; LD_{50} = 0.5 to 5 g/kg
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: None
3.10 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or throat if present in high concentrations. The effect is temporary.
3.11 Liquid or Solid Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
3.12 Odor Threshold: 5 ppm
3.13 IDLH Value: 150 ppm
3.14 OSHA PEL-TWA: 100 ppm
3.15 OSHA PEL-STEL: 300 ppm, 5 minute peak in any 3 hours
3.16 OSHA PEL-Ceiling: 200 ppm
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: Not flammable
4.2 Flammable Limits in Air: Not flammable
4.3 Fire Extinguishing Agents: Not pertinent
4.4 Fire Extinguishing Agents Not to Be Used: Not pertinent
4.5 Special Hazards of Combustion Products: Toxic, irritating gases may be generated in fires.
4.6 Behavior in Fire: Not pertinent
4.7 Auto Ignition Temperature: Not flammable
4.8 Electrical Hazards: Not pertinent
4.9 Burning Rate: Not flammable
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichiometric Air to Fuel Ratio: Not pertinent.
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): Not pertinent.
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Not pertinent
5.6 Inhibitor of Polymerization: Not pertinent

6. WATER POLLUTION

6.1 Aquatic Toxicity: Currently not available
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): None
6.4 Food Chain Concentration Potential: None
6.5 GESAMP Hazard Profile: Not listed

7. SHIPPING INFORMATION

7.1 Grades of Purity: Dry cleaning and industrial grades: 95+%
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Pressure-vacuum
7.5 IMO Pollution Category: B
7.6 Ship Type: 3
7.7 Barge Hull Type: 3

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Keep Away From Food
8.2 49 CFR Class: 6.1
8.3 49 CFR Package Group: III
8.4 Marine Pollutant: Yes
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	0
Instability (Yellow)	0

8.6 EPA Reportable Quantity: 100 pounds
8.7 EPA Pollution Category: B
8.8 RCRA Waste Number: U210/D039
8.9 EPA FWPCA List: Not listed

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 165.83
9.3 Boiling Point at 1 atm: 250°F = 121°C = 394°K
9.4 Freezing Point: -6.3°F = -22.4°C = 250.8°K
9.5 Critical Temperature: 656.6°F = 347°C = 620.2°K
9.6 Critical Pressure: Not pertinent
9.7 Specific Gravity: 1.63 at 20°C (liquid)
9.8 Liquid Surface Tension: 31.3 dynes/cm = 0.0313 N/m at 20°C
9.9 Liquid Water Interfacial Tension: 44.4 dynes/cm = 0.0444 N/m at 25°C
9.10 Vapor (Gas) Specific Gravity: Not pertinent
9.11 Ratio of Specific Heats of Vapor (Gas): 1.116
9.12 Latent Heat of Vaporization: 90.2 Btu/lb = 50.1 cal/g = 2.10×10^5 J/kg
9.13 Heat of Combustion: Not pertinent
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: Currently not available
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: Currently not available

NOTES

TETRACHLOROETHYLENE

TTE

9.20 SATURATED LIQUID DENSITY		9.21 LIQUID HEAT CAPACITY		9.22 LIQUID THERMAL CONDUCTIVITY		9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit inch per hour-square foot-F	Temperature (degrees F)	Centipoise
35	103.400	0	0.198		N	55	0.956
40	103.000	10	0.200		O	60	0.929
45	102.900	20	0.201		T	65	0.900
50	102.500	30	0.202			70	0.873
55	102.200	40	0.203		P	75	0.848
60	102.000	50	0.204		E	80	0.823
65	101.700	60	0.205		R	85	0.800
70	101.400	70	0.206		T	90	0.777
75	101.000	80	0.207		I	95	0.756
80	100.700	90	0.208		N	100	0.736
85	100.500	100	0.210		E	105	0.716
90	100.200	110	0.211		N	110	0.698
95	99.910	120	0.212		T	115	0.680
100	99.610	130	0.213			120	0.663
105	99.320	140	0.214			125	0.647
110	99.020	150	0.215			130	0.631
115	98.730	160	0.216			135	0.616
120	98.420	170	0.217			140	0.601
125	98.130	180	0.218			145	0.586
130	97.830	190	0.220			150	0.574
135	97.540	200	0.221			155	0.561
140	97.250	210	0.222			160	0.549
145	96.950					165	0.537
150	96.660					170	0.526
155	96.370					175	0.515
160	96.060						

9.24 SOLUBILITY IN WATER		9.25 SATURATED VAPOR PRESSURE		9.26 SATURATED VAPOR DENSITY		9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68	0.015	60	0.236	60	0.00782	0	0.108
		70	0.318	70	0.00929	25	0.110
		80	0.425	80	0.01216	50	0.113
		90	0.561	90	0.01575	75	0.116
		100	0.732	100	0.02022	100	0.118
		110	0.948	110	0.02571	125	0.120
		120	1.217	120	0.03242	150	0.122
		130	1.548	130	0.04055	175	0.125
		140	1.953	140	0.05032	200	0.127
		150	2.446	150	0.06196	225	0.129
		160	3.042	160	0.07563	250	0.131
		170	3.756	170	0.09215	275	0.132
		180	4.607	180	0.11130	300	0.134
		190	5.616	190	0.13380	325	0.136
		200	6.805	200	0.15940	350	0.138
		210	8.199	210	0.18910	375	0.139
		220	9.824	220	0.22330	400	0.141
		230	11.710	230	0.26230	425	0.142
		240	13.890	240	0.30660	450	0.143
		250	16.390	250	0.35680	475	0.144
		260	19.260	260	0.41330	500	0.146
		270	22.520	270	0.47680	525	0.147
		280	26.230	280	0.54790	550	0.148
						575	0.148
						600	0.149

VINYL CHLORIDE

VCM

CAUTIONARY RESPONSE INFORMATION

Common Synonyms	Gas	Colorless	Sweet odor
Chloroethylene VCL VCM Vinyl C monomer	Liquid floats and boils on water. Flammable, irritating visible vapor cloud is produced.		

Keep people away.
Evacuate.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Evacuate area in case of large discharge.
Avoid contact with liquid and vapor.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

FLAMMABLE.
POISONOUS GAS IS PRODUCED IN FIRE.
Flashback along vapor trail may occur.
May explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Cool exposed containers and protect man effecting shutoff with water.
Stop flow of gas if possible.
Let fire burn.
Extinguish small fires with dry chemical.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose, and throat.
If inhaled, will cause dizziness or difficult breathing.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will cause frostbite.
Flush affected areas with plenty of water.
DO NOT RUB AFFECTED AREAS.

Water Pollution

Not harmful to aquatic life.

1. CORRECTIVE RESPONSE ACTIONS

Dilute and disperse
Stop discharge

2. CHEMICAL DESIGNATIONS

2.1 **CG Compatibility Group:** 35; Vinyl halides
2.2 **Formula:** $CH_2=CHCl$
2.3 **IMO/UN Designation:** 2.0/1086
2.4 **DOT ID No.:** 1086
2.5 **CAS Registry No.:** 75-01-4
2.6 **NAERG Guide No.:** 116P
2.7 **Standard Industrial Trade Classification:** 51139

3. HEALTH HAZARDS

3.1 **Personal Protective Equipment:** Rubber gloves and shoes; gas-tight goggles; organic vapor canister or self-contained breathing apparatus.
3.2 **Symptoms Following Exposure:** INHALATION: high concentrations cause dizziness, anesthesia, lung irritation. SKIN: may cause frostbite; phenol inhibitor may be absorbed through skin if large amounts of liquid evaporate.
3.3 **Treatment of Exposure:** INHALATION: remove patient to fresh air and keep him quiet and warm; call a doctor; give artificial respiration if breathing stops. EYES AND SKIN: flush with plenty of water for at least 15 min.; for eyes, get medical attention; remove contaminated clothing.
3.4 **TLV-TWA:** 5 ppm
3.5 **TLV-STEL:** Not listed.
3.6 **TLV-Ceiling:** Not listed.
3.7 **Toxicity by Ingestion:** Not pertinent
3.8 **Toxicity by Inhalation:** Currently not available.
3.9 **Chronic Toxicity:** Chronic exposure may cause liver damage.
3.10 **Vapor (Gas) Irritant Characteristics:** Vapors cause moderate irritation such that personnel will find high concentrations unpleasant. The effect is temporary.
3.11 **Liquid or Solid Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin. May cause frostbite.
3.12 **Odor Threshold:** 260 ppm
3.13 **IDLH Value:** Not listed.
3.14 **OSHA PEL-TWA:** 1 ppm
3.15 **OSHA PEL-STEL:** 5 ppm average not exceeding any 15 min.
3.16 **OSHA PEL-Ceiling:** Not listed.
3.17 **EPA AEGL:** Not listed

4. FIRE HAZARDS

4.1 **Flash Point:** −110°F O.C.
4.2 **Flammable Limits in Air:** 3.6 - 33%
4.3 **Fire Extinguishing Agents:** For small fires use dry chemical or carbon dioxide. For large fires stop flow of gas. Cool exposed containers with water.
4.4 **Fire Extinguishing Agents Not to Be Used:** Not pertinent
4.5 **Special Hazards of Combustion Products:** Forms highly toxic combustion products such as hydrogen chloride, phosgene, and carbon monoxide.
4.6 **Behavior in Fire:** Container may explode in fire. Gas is heavier than air and may travel considerable distance to a source of ignition and flash back.
4.7 **Auto Ignition Temperature:** 882°F
4.8 **Electrical Hazards:** Class I, Group D
4.9 **Burning Rate:** 4.3 mm/min.
4.10 **Adiabatic Flame Temperature:** Currently not available
4.11 **Stoichometric Air to Fuel Ratio:** 11.9 (calc.)
4.12 **Flame Temperature:** Currently not available
4.13 **Combustion Molar Ratio (Reactant to Product):** 4.0 (calc.)
4.14 **Minimum Oxygen Concentration for Combustion (MOCC):** N_2 diluent: 10.0-13.4%

5. CHEMICAL REACTIVITY

5.1 **Reactivity with Water:** No reaction
5.2 **Reactivity with Common Materials:** No reaction
5.3 **Stability During Transport:** Stable
5.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
5.5 **Polymerization:** Polymerizes in presence of air, sunlight, or heat unless stabilized by inhibitors.
5.6 **Inhibitor of Polymerization:** Not normally used except when high temperatures are expected. Then 40-100 ppm of phenol used.

6. WATER POLLUTION

6.1 **Aquatic Toxicity:** None
6.2 **Waterfowl Toxicity:** None
6.3 **Biological Oxygen Demand (BOD):** None
6.4 **Food Chain Concentration Potential:** None
6.5 **GESAMP Hazard Profile:**
Bioaccumulation: 0
Damage to living resources: MA
Human Oral hazard: MA
Human Contact hazard: II
Reduction of amenities: XXX

7. SHIPPING INFORMATION

7.1 **Grades of Purity:** Commercial or technical 99+%
7.2 **Storage Temperature:** Under pressure; ambient At atm. pressure; low
7.3 **Inert Atmosphere:** No requirement
7.4 **Venting:** Under pressure; safety relief At atm. pressure; pressure-vacuum
7.5 **IMO Pollution Category:** Currently not available
7.6 **Ship Type:** 2
7.7 **Barge Hull Type:** 2

8. HAZARD CLASSIFICATIONS

8.1 **49 CFR Category:** Flammable gas
8.2 **49 CFR Class:** 2.1
8.3 **49 CFR Package Group:** Not pertinent.
8.4 **Marine Pollutant:** No
8.5 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	4
Instability (Yellow)	2

8.6 **EPA Reportable Quantity:** 1 pound
8.7 **EPA Pollution Category:** X
8.8 **RCRA Waste Number:** U043/D043
8.9 **EPA FWPCA List:** Not listed

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 **Physical State at 15° C and 1 atm:** Gas
9.2 **Molecular Weight:** 62.50
9.3 **Boiling Point at 1 atm:** 7.2°F = 13.8°C = 258.4°K
9.4 **Freezing Point:** −244.8°F = −153.8°C = −119.4°K
9.5 **Critical Temperature:** 317.1°F = 158.4°C = 431.6°K
9.6 **Critical Pressure:** 775 psia = 52.7 atm = 5.34 MN/m²
9.7 **Specific Gravity:** 0.969 at −13°C (liquid)
9.8 **Liquid Surface Tension:** 18.0 dynes/cm = 0.0180 N/m at 25°C
9.9 **Liquid-Water Interfacial Tension:** (est.) 30 dynes/cm = 0.03 N/m at 20°C
9.10 **Vapor (Gas) Specific Gravity:** 2.2
9.11 **Ratio of Specific Heats of Vapor (Gas):** 1.186
9.12 **Latent Heat of Vaporization:** 160 Btu/lb = 88 cal/g = 3.7 X 10^5 J/kg
9.13 **Heat of Combustion:** −8136 Btu/lb = −4520 cal/g = −189.1 X 10^5 J/kg
9.14 **Heat of Decomposition:** Not pertinent
9.15 **Heat of Solution:** Not pertinent
9.16 **Heat of Polymerization:** −729 Btu/lb = −405 cal/g = 16.9 X 10^5 J/kg
9.17 **Heat of Fusion:** 18.14 cal/g
9.18 **Limiting Value:** Currently not available
9.19 **Reid Vapor Pressure:** 75 psia

NOTES

VINYL CHLORIDE

VCM

9.20 SATURATED LIQUID DENSITY		9.21 LIQUID HEAT CAPACITY		9.22 LIQUID THERMAL CONDUCTIVITY		9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit inch per hour-square foot-F	Temperature (degrees F)	Centipoise
0	61.960	-30	0.258		N	-10	0.287
5	60.710	-20	0.265		O	-5	0.281
		-10	0.272		T	0	0.276
		0	0.279			5	0.271
					P		
					E		
					R		
					T		
					I		
					N		
					E		
					N		
					T		

9.24 SOLUBILITY IN WATER		9.25 SATURATED VAPOR PRESSURE		9.26 SATURATED VAPOR DENSITY		9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68	0.099	-50	3.384	-50	0.04616	0	0.185
		-40	4.591	-40	0.06245	25	0.192
		-30	5.986	-30	0.08065	50	0.198
		-20	7.588	-20	0.10140	75	0.205
		-10	9.514	-10	0.12710	100	0.211
		0	12.440	0	0.15790	125	0.217
		10	15.510	10	0.19360	150	0.224
		20	19.410	20	0.23580	175	0.230
		30	23.920	30	0.28440	200	0.235
		40	29.220	40	0.34050	225	0.241
		50	35.430	50	0.40470	250	0.247
		60	42.630	60	0.47790	275	0.252
		70	50.940	70	0.56090	300	0.257
		80	60.480	80	0.65250	325	0.263
		90	71.340	90	0.75570	350	0.268
		100	83.660	100	0.87060	375	0.273
		110	97.590	110	0.99740	400	0.277
		120	113.200	120	1.13790	425	0.282
						450	0.286
						475	0.291
						500	0.295
						525	0.299
						550	0.303
						575	0.307
						600	0.311

1,2-DICHLOROETHYLENE

DEL

CAUTIONARY RESPONSE INFORMATION

Common Synonyms	Liquid	Colorless	Sweet pleasant odor
Acetylene dichloride trans-1,2-Dichloroethylene cis-1,2-Dichloroethylene sym-Dichloroethylene Dioform	Sinks in water. Flammable, irritating vapor is produced.		

Evacuate.
Keep people away.
Wear goggles and self-contained breathing apparatus.
Shut off ignition sources. Call fire department.
Notify local health and pollution control agencies.
Protect water intakes.

Fire

FLAMMABLE.
POISONOUS GASES MAY BE PRODUCED IN FIRE.
Containers may explode in fire.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Extinguish with dry chemicals, foam or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

Call for medical aid.

VAPOR
If inhaled will cause dizziness, nausea, vomiting, or difficult breathing.
Move victim to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Harmful if swallowed.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. CORRECTIVE RESPONSE ACTIONS

Stop discharge
Collection Systems: Pump
Collection Systems: Dredge
Do not burn

2. CHEMICAL DESIGNATIONS

2.1 CG Compatibility Group: Not listed.
2.2 Formula: ClCH = CHCl
2.3 IMO/UN Designation: 3.2/1150
2.4 DOT ID No.: 1150
2.5 CAS Registry No.: 540-59-0
2.6 NAERG Guide No.: 132P
2.7 Standard Industrial Trade Classification: 51138

3. HEALTH HAZARDS

3.1 Personal Protective Equipment: Rubber gloves; safety goggles; air supply mask or self- contained breathing apparatus.
3.2 Symptoms Following Exposure: Inhalation causes nausea, vomiting, weakness, tremor, epigastric cramps, central nervous depression. Contact with liquid causes irritation of eyes and (on prolonged contact) skin. Ingestion causes slight depression to deep narcosis.
3.3 Treatment of Exposure: INHALATION: remove from further exposure; if breathing is difficult, give oxygen; if victim is not breathing, give artificial respiration, preferably mouth-to-mouth; give oxygen when breathing is resumed; call a physician. EYES: flush with water for at least 15 min. SKIN: wash well with soap and water. INGESTION: give gastric lavage and cathartics.
3.4 TLV-TWA: 200 ppm
3.5 TLV-STEL: Not listed.
3.6 TLV-Ceiling: Not listed.
3.7 Toxicity by Ingestion: Grade 2; oral LD_{50} = 770 mg/kg (rat)
3.8 Toxicity by Inhalation: Currently not available.
3.9 Chronic Toxicity: Produces liver and kidney injury in experimental animals.
3.10 Vapor (Gas) Irritant Characteristics: Currently not available
3.11 Liquid or Solid Characteristics: Currently not available
3.12 Odor Threshold: Currently not available
3.13 IDLH Value: 1,000 ppm
3.14 OSHA PEL-TWA: 200 ppm
3.15 OSHA PEL-STEL: Not listed.
3.16 OSHA PEL-Ceiling: Not listed.
3.17 EPA AEGL: Not listed

4. FIRE HAZARDS

4.1 Flash Point: 37°F C.C.
4.2 Flammable Limits in Air: 9.7%-12.8%
4.3 Fire Extinguishing Agents: Dry chemical, foam, carbon dioxide
4.4 Fire Extinguishing Agents Not to Be Used: Water may be ineffective.
4.5 Special Hazards of Combustion Products: Phosgene and hydrogen chloride fumes may form in fires.
4.6 Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back.
4.7 Auto Ignition Temperature: 860°F
4.8 Electrical Hazards: Currently not available
4.9 Burning Rate: 2.6 mm/min.
4.10 Adiabatic Flame Temperature: Currently not available
4.11 Stoichiometric Air to Fuel Ratio: 9.5 (calc.)
4.12 Flame Temperature: Currently not available
4.13 Combustion Molar Ratio (Reactant to Product): 4.0 (calc.)
4.14 Minimum Oxygen Concentration for Combustion (MOCC): Not listed

5. CHEMICAL REACTIVITY

5.1 Reactivity with Water: No reaction
5.2 Reactivity with Common Materials: No reaction
5.3 Stability During Transport: Stable
5.4 Neutralizing Agents for Acids and Caustics: Not pertinent
5.5 Polymerization: Will not occur under ordinary conditions of shipment. The reaction is not vigorous.
5.6 Inhibitor of Polymerization: None used

6. WATER POLLUTION

6.1 Aquatic Toxicity: Currently not available
6.2 Waterfowl Toxicity: Currently not available
6.3 Biological Oxygen Demand (BOD): Currently not available
6.4 Food Chain Concentration Potential: None
6.5 GESAMP Hazard Profile:
Bioaccumulation: 0
Damage to living resources: 1
Human Oral hazard: 1
Human Contact hazard: 1
Reduction of amenities: X

7. SHIPPING INFORMATION

7.1 Grades of Purity: Commercial
7.2 Storage Temperature: Ambient
7.3 Inert Atmosphere: No requirement
7.4 Venting: Pressure-vacuum
7.5 IMO Pollution Category: Currently not available
7.6 Ship Type: Currently not available
7.7 Barge Hull Type: Currently not available

8. HAZARD CLASSIFICATIONS

8.1 49 CFR Category: Flammable liquid
8.2 49 CFR Class: 3
8.3 49 CFR Package Group: II
8.4 Marine Pollutant: No
8.5 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Instability (Yellow)	2

8.6 EPA Reportable Quantity: 1000 pounds
8.7 EPA Pollution Category: C
8.8 RCRA Waste Number: U079
8.9 EPA FWPCA List: Not listed

9. PHYSICAL & CHEMICAL PROPERTIES

9.1 Physical State at 15° C and 1 atm: Liquid
9.2 Molecular Weight: 97.0
9.3 Boiling Point at 1 atm: cis: 140°F = 60°C = 333°K trans: 118°F = 48°C = 321°K
9.4 Freezing Point: cis: −114°F = −81°C = 192°K trans: −58°F = −50°C = 223°K
9.5 Critical Temperature: Not pertinent
9.6 Critical Pressure: Not pertinent
9.7 Specific Gravity: 1.27 at 25°C (liquid)
9.8 Liquid Surface Tension: 24 dynes/cm = 0.024 N/m at 20°C
9.9 Liquid-Water Interfacial Tension: (est.) 30 dynes/cm = 0.030 N/m at 20°C
9.10 Vapor (Gas) Specific Gravity: 3.34
9.11 Ratio of Specific Heats of Vapor (Gas): 1.1468
9.12 Latent Heat of Vaporization: 130 Btu/lb = 72 cal/g = 3.0 X 10^5 J/kg
9.13 Heat of Combustion: −4,647.2 Btu/lb = −2,692.9 cal/g = −112.67 X 10^5 J/kg
9.14 Heat of Decomposition: Not pertinent
9.15 Heat of Solution: Not pertinent
9.16 Heat of Polymerization: Not pertinent
9.17 Heat of Fusion: Currently not available
9.18 Limiting Value: Currently not available
9.19 Reid Vapor Pressure: Currently not available

NOTES

1,2-DICHLOROETHYLENE

DEL

9.20 SATURATED LIQUID DENSITY	
Temperature (degrees F)	Pounds per cubic foot
35	81.920
40	80.520
45	80.510
50	80.400
55	80.190
60	79.980
65	79.780
70	79.570
75	79.360
80	79.150
85	78.940
90	78.740
95	78.530
100	78.320
105	78.110
110	77.900
115	77.690
120	77.480
125	77.290
130	77.070
135	76.860
140	76.650

9.21 LIQUID HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
35	0.193
40	0.196
45	0.198
50	0.200
55	0.202
60	0.204
65	0.207
70	0.209
75	0.211
80	0.213
85	0.216
90	0.218
95	0.220
100	0.222
105	0.224
110	0.227
115	0.229
120	0.231
125	0.233
130	0.236
135	0.238
140	0.240

9.22 LIQUID THERMAL CONDUCTIVITY	
Temperature (degrees F)	British thermal unit inch per hour-square foot-F
65	0.907
70	0.894
75	0.882
80	0.869
85	0.857
90	0.844
95	0.832
100	0.819
105	0.807
110	0.794
115	0.782
120	0.769
125	0.757
130	0.744

9.23 LIQUID VISCOSITY	
Temperature (degrees F)	Centipoise
40	0.476
50	0.454
60	0.432
70	0.411
80	0.393
90	0.378
100	0.360
110	0.345
120	0.331
130	0.319
140	0.307
150	0.296
160	0.286
170	0.276
180	0.267
190	0.259
200	0.251
210	0.244

9.24 SOLUBILITY IN WATER	
Temperature (degrees F)	Pounds per 100 pounds of water
68	0.630

9.25 SATURATED VAPOR PRESSURE	
Temperature (degrees F)	Pounds per square inch
55	3.000
60	3.396
65	3.824
70	4.297
75	4.817
80	5.389
85	6.016
90	6.702
95	7.453
100	8.272
105	9.164
110	10.130
115	11.190
120	12.330
125	13.560
130	14.900
135	16.340
140	17.890

9.26 SATURATED VAPOR DENSITY	
Temperature (degrees F)	Pounds per cubic foot
55	0.06284
60	0.06806
65	0.06587
70	0.07336
75	0.08141
80	0.09023
85	0.09968
90	0.11020
95	0.12140
100	0.13360
105	0.14660
110	0.16070
115	0.17580
120	0.19220
125	0.20960
130	0.22830
135	0.24820
140	0.26960

9.27 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	British thermal unit per pound-F
0	0.150
20	0.153
40	0.156
60	0.159
80	0.162
100	0.165
120	0.167
140	0.170
160	0.173
180	0.176
200	0.179
220	0.182
240	0.185
260	0.188
280	0.191
300	0.194
320	0.197
340	0.200
360	0.203
380	0.205
400	0.208
420	0.211
440	0.214

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